DOCUMENT RESUME

ED 084 014 PS 006 826

AUTHOR Sinclair, Caroline
TITLE Movement and Movement Patterns of Early Childhood. [Complete Report].
INSTITUTION Richmond Public Schools, Va.; Virginia State Dept. of Education, Richmond.
PUB DATE 6 Jan 70
NOTE 130p.; ED 053 796 is the shortened version of this study

EDRS PRICE MF-$0.65 HC-$6.58
DESCRIPTORS Age Differences; *Early Childhood; Individual Differences; *Longitudinal Studies; *Motion; *Physical Development; *Psychomotor Skills; Sex Differences

ABSTRACT

This study investigated the progressive development in movement and movement patterns of children ages 2-6. Data were collected over a 3-year period at six-month intervals, based on films of 57 children performing 25 motor tasks. The results are presented along two dimensions: (1) Descriptive analysis of progress of young children in movement with indications of age, sex, and individual differences, and (2) descriptive analysis of development of movement patterns in each of 25 basic movement activities during early childhood. It was concluded that an identifiable sequence does occur in movement of children and that similar movement patterns emerge; that identifiable variations may also be expected; that a young child's movement development may be assessed by his progress over time and by comparisons with children of his own age; that general movement characteristics appear to be indicative of development in movement. These are dynamic balance, opposition and symmetry, total body assembly, rhythmic locomotion, eye-hand efficiency, agility, and postural adjustment. (DP)

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ED 084014

MOVEMENT AND MOVEMENT PATTERNS OF EARLY CHILDHOOD

by

Caroline Sinclair, Ph. D.

January 6, 1970

RICHMOND PUBLIC SCHOOLS
and
VIRGINIA STATE DEPARTMENT OF EDUCATION

RICHMOND, VIRGINIA

PS 006826

ED 084014

AN ABSTRACT
OF
MOVEMENT AND MOVEMENT PATTERNS OF EARLY CHILDHOOD

Caroline B. Sinclair
Richmond Public Schools and State Department of Education
Richmond, Virginia

Purpose. To determine the progressive development in movement and movement patterns of young children (ages 2-6). Method. Data were collected over a period of 3 years during which 57 children 2-6 years of age were studied at intervals of 6 months in performance of 25 motor tasks. Performances were recorded on film, studied under slow motion projection, and analyzed on forms developed for this purpose. Eight general characteristics were selected for special study. A scoring system was established; all records were studied in terms of success, elements of performance, general characteristics displayed, and movement pattern. Results. (1) descriptive analyses of progress of young children in movement with indications of age, sex, and individual differences and (2) descriptive analyses of development of movement patterns in each of 25 basic movement activities (motor tasks) during early childhood. It was concluded that an identifiable sequence does occur in movement of children and that similar movement patterns emerge; that identifiable variations may also be expected; that a young child's development in movement may be assessed by his progress over a period of time and by comparison with that of children of his own age; that general movement characteristics appear to be indicative of development in movement; these are: (1) dynamic balance, (2) opposition and symmetry, (3) total body assembly, (4) rhythmic locomotion, (5) eye-hand efficiency, (6) agility, and (7) postural adjustment.

Caroline B. Sinclair
Box 452
Gloucester, Virginia 23061

PS 006820

4107/80

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Caroline Sinclair, Ph.D.

ERRATA:

1. Table II - The table should be Race and Sex of Subjects. (See List of Tables and Table II.)

2. Notes for Table III - This page should be placed immediately after Table III.

MOVEMENT AND MOVEMENT PATTERNS OF EARLY CHILDHOOD

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Preface

This report has been prepared in the hope that it will be read by many people with diverse responsibilities and perhaps for different purposes.

Researchers will find Chapters II, IV, and V of most value but they will wish to sample several sections of Chapter III also.

Teachers and students of early childhood will be most concerned with Chapter III and especially Sections I, II, III, and IV.

Physical educators will find their greatest focus of interest in Sections III and V of Chapter III.

Psychologists and specialists in child growth and development will probably find Section V of less interest than other portions of Chapter III.

Pediatricians, pediatric nurses, physical therapists, occupational therapists and other medical and medically related personnel will find Section II of Chapter III most interesting but they may find other portions pertinent also.

It has been a happy privilege for me to work with the Research Department (formerly the Department of Research and Development) of the Richmond Public Schools and the Division of Educational Research of the Virginia State Department of Education in this study. I am grateful for the interest and guidance of Dr. James W. Tyler, Assistant Superintendent of Richmond Public Schools (formerly Director of Research and Development); Dr. Robert V. Turner, Director of Research, Richmond Public Schools; Mr. Charles E. Clear, Director of the Division of Educational Research, State Department of Education and also to their associates and staff. The enthusiasm, inspiration, and information offered by Mrs. Mildred Dickerson, Assistant Professor of Education, Madison College and Dr. Lydia Fauls, Clinical Psychologist (formerly Supervisor of Early Childhood Education, Richmond Public Schools) at all times has been invaluable. Miss Celeste Jones, Principal of Madison and Grace Arents Elementary Schools and Mrs. Gertrude Freeman, teacher of

four-year-olds at Madison, were especially helpful in the early stages of the study; to these and all other principals and teachers of the schools in which I worked I am most grateful.

My thanks go also to Dr. H. I. Willett, former Superintendent of Richmond Public Schools and his successor Mr. L. D. Adams and to Mrs. Mildred Mims, Director of Belle Bryan Day Nursery and her teachers for without their support this study could not have been made.

-Caroline Sinclair, Ph.D.

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Chapter I

Introduction

I. Problem

Three factors arising as separate but related emphases in current education point to the need for this study - education for the pre-school years, treatment for brain damaged and underachieving children, and perceptual-motor development in relationship to total learning. In the study of these factors the motor development of the child and his success in movement have been stressed but little has been added to the studies of the 1930's (Bayley 1935, Goodenough 1935, Guthridge 1930, et als.) to document the movement development of the normal child from two to six. Parents and teachers need help in evaluating movement progress in early childhood. In the developing complex of motor reactions criteria are needed for appraisal. Recent advances in the knowledge of child growth and development and a continuous flow of information from the laboratories of psychology and physiology make possible an excellent integration of new information about the movement of the pre-schooler into the total understanding of children.

II. Purpose and Objectives

A. The purpose of this study is to determine the progressive development in movement and movement patterns of young children (ages 2-6).

B. Related objectives are:

1. To describe the progress in development of movement of children from 2 to 6 years of age
2. To identify general movement characteristics which may be studied for significance in appraisal of growth and development
3. To determine the development of pattern in common movement tasks

4. To study variations in movement and movement patterns among normal subjects 2 to 6 years of age

III. Preparation for the Study

Stimulated by newspaper and journal reports of successful work by educators in remedial reading and special education, and by study and observation in years of teaching physical education, the investigator began in 1964-65 to work with her colleagues in preliminary consultation and experiment in the study of young children. In the summer of 1965 she received a travel grant from Madison College and observed and studied related programs at Purdue University, the University of Chicago, and the University of Wisconsin. During the 1965-66 session she participated with Mrs. Mildred Dickerson in an observational and study program of the nursery school at Anthony-Seegar School, Madison College. During this time she experimented with photography and time-motion projection and developed preliminary plans with Dr. J. W. Tyler, Director of Research and Development, Richmond Public Schools. Since the investigator would retire from the Madison College faculty July 1, 1966, it would be possible for her to give a major portion of her time to research in the succeeding years.

During the spring and summer of 1966 contacts were made with Richmond Schools personnel and through Dr. Lydia Fauls, Supervisor of Early Childhood Education, with Belle Bryan Day Nursery, a United Fund Agency located adjacent to the Medical College of Virginia. At this time the Richmond Public Schools had a well established nine-month program for four-year-olds; by starting with a selected group of these children at Madison Elementary School and also with two and three-year-olds from Belle Bryan it would be possible to study subjects of several ages in their development through their pre-school years.

Chapter II

Procedures

This research was designed as a three-year study; it was started August 30, 1966, under the auspices of the Richmond Public Schools and was approved in the summer of 1967 as a pilot study by the State Department of Education (Division of Educational Research and Statistics). The data were collected in each of two semesters over three school sessions terminating in May 1969.

I. Subjects

Subjects were chosen by the criteria of age, availability and normality attested to by medical examination, psychological test and teacher's estimate. Subjects were enrolled throughout the six phases of the study when possible (see Table I). Records were obtained for 57 subjects for one to six phases; when enrolled the subjects ranged in age from 2 years 1 month to 4 years 11 months; the oldest group, started at four years, was continued into the first semester of first grade.

A second group of two-year-olds was enrolled in the study in 1967-68 in order to give a larger number (30) for study at this age. In the 1968-69 session only the children previously enrolled in the study were included.

Of the 57 subjects, 13 were Negro and girls outnumbered boys 35-22 (Table II).

II. Movement Tasks

The movement tasks for study varied from 18-25 in the six phases; the number was also varied for each age group within each phase except the first where the baseline was established at 18 and all children were given an opportunity to perform each of the eighteen tasks.

The movement tasks were selected as those commonly considered fundamental and basic to the performance of more complex motor actions; in some instances they were adjusted to allow for age increases in size, strength, or skill.

Limitations of time and money dictated the omission of some tasks for some age groups in Phases II and IV but a final record was obtained for each subject in each of the tasks in the terminal phases (V and VI). Table III lists the movement tasks, indicates the phases and ages for which they were used, and notes the ways in which they were varied.

Appendix I lists equipment used in the movement.

In each case the movement task was presented to the subject as simply as possible. The stage was set (equipment was in place, spaces marked, etc.), the child was placed at the proper starting point and was asked to perform the task - to run to the tree, to climb up the ladder, to hit the ball - in the most objective terms available; he was not instructed how to perform; in rare cases where experience and vocabulary were limited the investigator demonstrated. Every effort was made to encourage a naive performance by the child rather than one patterned after another's performance, but certainly some imitation occurred. In each case the child was asked to wait for the signal "Go" as this permitted the investigator to get in place at the camera and to film the entire performance. If the task was not performed successfully, a second or even a third trial might be given but the child was encouraged to experience gratification at his own level of performance.

III. Collection of Data

The study was conducted by observation, motion photography, and analysis of the performance of the subjects in 18-25 movement tasks in each of six school semesters hereafter designated as Phases I to VI.

Before collecting data it was necessary for the investigator to establish rapport with these young children. This she did by daily visits to the classroom and playground and, with the help of the teacher, she became involved in the children's activities. During the first two phases the teachers released their

aides to assist the investigator when filming was started. During the last four phases an aide was assigned to the investigator and assisted regularly with setting up the equipment and management of the subjects. Recording, filming, and analysis were done entirely by the investigator.

In the first phase and before filming the movement tasks, a baseline was established for further investigation by observing each subject and recording in detail the performance or non-performance of each of 18 movement tasks selected as fundamental, simple, and commonly used.

During the three years of research, adjustments were made to provide for tasks better suited to age groups, more discriminating analysis forms, and better filming situations.

In the collection of data the children were grouped by age for assignment of motor tasks; they were listed in age-order (youngest to oldest) within the groups so that the investigator might be constantly reminded of age differences. A child who had passed her second birthday but had not reached her third by October 1, was considered <u>two</u> for the school session; other age groups were similarly established.

After three weeks of intensive trial of the Kephart Movement Pattern Check Lists[1] and with the permission of Dr. Newell C. Kephart (Appendix III) then of Purdue University, revisions were made and new analysis forms were devised especially for the young children and special conditions of this study. New forms were developed as new tasks were added and slight revisions of others were made from time to time.

[1]Godfrey and Kephart, <u>Movement Patterns and Motor Education</u>, pp. 161-170.

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For each movement task a standard of success was established and a number (6-10) of observable elements were checked as definitive of the way in which the subject performed. Samples of the analysis forms developed are given in Appendix II. The elements for each task are listed and standards for success and mature pattern are stated on pp. 28-44.

In order to be assured of the normality of the subjects and to obtain related information, each subject was examined by a physician and each child was given one or more psychological tests by a qualified psychologist. These were given in the first and second years of the study and in the second half of the subject's participation in the study (at ages 2, 3, and 4). In Phase VI a teacher's estimate of the subject's achievement was obtained.

Information available from the agencies as to the child's parentage, family, economic situation, health, and social status was recorded.

IV. Equipment

Equipment for the movement tasks was provided by the schools or by the investigator; as the study developed and more locations became involved, she found it necessary to pack the equipment and take it from school to school. Since this was not practicable with climbing equipment there was considerable variation in the climbing apparatus used for five and six year olds. Most of the equipment (Appendix I) is portable, readily available, and inexpensive.

The motion picture camera used for photography was a Pathe PR-16AT/BTL. Film used throughout most of the study was Kodak TriX, Type 7278, black and white. Most of the filming was done outdoors with ASA of 160 but when indoors under Tungsten at ASA of 125. For experimental purposes and for illustrated lectures some color film was used. For this Kodak Ektachrome film, Type 7421, and an improvised filter (patterned after a Wrattan 85) were employed.[2]

[2]Appreciation is expressed to Messrs. Richey, Dean and Wood, formerly of TV and Motion Pictures and now of Metrographics, Richmond, Va., for help generously given with problems of photography.

V. Personnel and Facilities

This research was conducted at Madison Elementary School of Richmond and also at Grace Arents, Baker, Oak Grove Annex, Webster Davis, Mosby, Woodville, Lee, Mary Munford, William Fox, and Clark Springs of Richmond; at Jacob Adams of Henrico County; at St. Andrews of the Episcopal Church in Richmond; and at Belle Bryan Day Nursery, a United Fund Agency of Richmond. Permissions were received from the governing personnel of the agencies and from the parents of the children enrolled. When weather permitted, the playgrounds and grassy areas were utilized; in most schools the principal was able to provide an area for indoor use. At Belle Bryan most of the study was conducted on adjacent grounds belonging to the Medical College of Virginia.

Members of the staffs of the Division of Educational Research and Statistics, State Department of Education, and of Research and Development, Richmond Public Schools, served as consultants and advisors for the study. Other valuable help came from Miss Frances Mays, State Supervisor of Health and Physical Education; Dr. Lydia Fauls of the Richmond Public Schools; Dr. Milton Jacobson of the University of Virginia; Dr. W. E. Laupus and Dr. Colon Rivadeneira of Pediatrics, Medical College of Virginia; members of the Madison College faculty; and members of the staff of the American Association for Health and Physical Education. Principals, teachers, and teacher aides were helpful in many ways. The investigator was assisted by aides who worked with her in Phases III-VI, by the stenographic staff of Research and Development (now the Research Department), Richmond Public Schools, and by graduate students in the Bureau of Educational Research, University of Virginia.

VI. Analysis of Data

A. Movement Development

Movement performance recorded on Tri X film (about 80,000 feet) was analyzed by the investigator on the Movement Task Analysis Forms under slow-motion projection for 25 tasks.

The projector used was a Bell-Howell Time-Motion Analyzer (silent 16 mm.) with 800-1500 fpm speed and a clutch which permits prolonged single-frame view and hand-projection frame by frame at chosen speed.

All film was analyzed during or immediately following the phase of study.

In order to appraise the reliability and validity of this method of analysis, one hundred fifty feet of film of Phase I were analyzed by the investigator and then sent in turn with analysis forms to three physical educators selected for their special qualifications in the analysis of human movement: Dr. Lawrence Rarick of the University of Wisconsin, Dr. Barbara Godfrey of the University of Missouri, and Dr. Helen Eckert of the University of California at Berkeley. The analysis of the investigator and the analyses of the three selected analysts were studied and compared by Dr. Patricia Bruce and Dr. Leotus Morrison of Madison College. A frequency count of the disagreements of each reviewer with the analysis of the investigator was made for a total of 50 disagreements in 600 responses (8.3 per cent). A copy of the letter from Dr. Bruce and Dr. Morrison attesting to the reliability of the analysis and the validity of the instrument will be found in Appendix III.

After completion of the analysis of movement tasks for each phase scores were assigned to each child for each task. This system of scoring was applied methodically in each phase of the study:

Successful and all elements exhibited = 5

Successfull and all elements save one exhibited = 4

Successful and conforming to mature pattern of movement (this to be defined distinctively for each task)	= 3
Successful but not meeting standard	= 2
Partially and objectively successful and to a marked degree	= 1

Scores were also given in one-half points. The subject's motor score for Phase I was determined by summing the scores of the motor tasks and dividing by 18 ($mn = \frac{\Sigma \text{ of scores}}{N}$). For the other five phases the following formula was used to determine the motor score:

$$\text{Motor score} = \frac{\Sigma \text{ of scores on motor tasks} \times 18}{N(\text{number of motor tasks})}$$

The task scores and the motor scores were orgainzed and studied by age and sex. Although the motor scores for the six phases have been computed to permit comparable evaluation, it should be noted that relationships are best studied within age groups because of varying conditions and standards for the movement tasks.

B. Movement Characteristics

Characteristics common to many movement tasks have been selected for special study. This list was compiled from previous study and observation and after observing and analyzing data in the first two phases of the study. The list follows:

1. Dominance (side preference for paired parts)
2. Opposition (the synchronized use of opposite hand and foot in the upright position and cross-laterality in quadripedal movement) and symmetry (including foot-over-foot action in climbing and descending)
3. Dynamic balance (the ability to retain equilibrium while moving)
4. Total body assembly (using the parts of the body (a) as levers in sequence to acquire speed by providing a summation of forces over a short period of time or (b) using parts of the body simultaneously as a system of levers for an effort of force against considerable resistance or (c) using the parts of the body for power release as

in (a) and (b) above for a combination of speed and force

5. Rhythmic two-part locomotion (as in gallop, slide, skip)

6. Eye-hand efficiency in manual response to a static or moving object

7. Agility (maneuverability of the body)

8. Postural adjustment

At the end of each of Phases I-VI the activity analysis records were reviewed to ascertain the appearance of these characteristics and their manifestations were summarized. At the completion of Phase VI these findings were summarized for each age group; they appear in Tables X-XVII and in Charts 1-30.

The data were recorded on key punch cards and submitted for statistical analysis in order to determine the relationship of each with movement development as represented by the motor score and the significance, if any, of these characteristics in predicting motor success as measured by motor score. See Tables XIX, XX, XXII, XXIII.

C. Individual Differences

In order to study individual variations a case study was developed for each subject (Appendix IV) and a table was made showing the range of scores for each motor task at each age level (Table XXI).

For the ten subjects with the greatest positive and negative deviations from the means of motor scores a special analysis was made. This analysis is presented in Tables XXII and XXIII.

D. Development of Movement Patterns

An age analysis was made to ascertain the changes, if any, in the pattern of the successful motor task as it developed. These changes are presented on pages 27-45.

Chapter III

Presentation of Data

I. General Factors

In order to establish a suitable context for the determination of movement development, several general factors were recorded and considered and, if practicable, these were studied in relation to the subjects' motor scores. The general factors of age, sex, race, intelligence (I.Q.), maturity (M.Q.), achievement (teachers' estimate), and reading readiness (Metropolitan Reading Readiness scores) are presented in their relationship to motor scores in Table IV.

A. Age

A basic assumption of this study is that movement is a developing process during the early years of childhood. This assumption is supported by the increasing motor scores from 2 to 6 (Table V), by the development and maturation of movement patterns through these years (pp. 27-45), by the increasing ability evidenced in time and distance for four athletic events (Table VI), by positive correlation of age and motor score at all ages (Table IV) and by Charts 1-30. The correlations of age and motor score which are .67 and .60 at 2 and 3 fall sharply to .12 (at 4 and 6) and .25 (at 5) at later ages (Table IX). Since these correlations are of age within age group it appears than an age difference of less than a year is of less significance to motor score after a child attains the age of 3.

It is evident that older children will perform certain motor acts which they were unable to do at an earlier age and that their ability to cope with space, time, and distance improves with age.

B. Sex

The correlation of motor score with sex was found to be positive for females at ages 2 and 3 and positive for males at 4, 5, and 6, with a sharp rise from .21 at 5 to .41 at 6 (Table IV). A comparison of boys' and girls' means of motor scores revealed a difference in favor of girls at 2, similar mean scores at 3, and a small difference in favor of boys at 4 and later, rising to 12.1 points or 20% of the mean score for boys and girls together at 6 (Table V and Charts 1-30). Girls surpassed boys in the performance of 15 of 23 tasks at 2 but were surpassed by boys in 17 of 25 tasks at 4. The age of 4 was marked by increased gains in task scores, especially for boys, and by high positive correlations of several movement characteristics with maleness including the three aspects of total body assembly.

The greatest difference in performance of boys and girls was found in throwing in which boys were superior in task scores at ages 3 to 6 and in measured distance at 4 and thereafter with increasing differences at 5 and 6 (Tables VI and VII and Chart 23). Girls were superior at 6 in hitting (but not at previous ages), galloping, sliding, and the standing broad jump in which, however, the boys attained the greater distance. Girls outscored boys at 5 but not at 6 in the forward roll, hopping, the running high jump, skipping, and running though in the latter the boys made the better time. See Charts 26-30.

C. Race

The majority of the subjects were white, but 13 of the 57 subjects were of the black race. Eleven of these were enrolled in Phase I as 4-year-olds and two were enrolled in Phase II as 2-year-olds. All completed the study. Thus 23% of the subjects were of the minority race. The correlation of white race with motor score was found to be negative at all ages with a range of .17 to .33 (Table IV).

D. Intelligence

In order to determine the normality of subjects, all were tested by a qualified psychologist and I.Q.'s were determined. Correlation with motor score was highest at 2 (.25) and low though positive at all other ages (Table IV).

For 4-year-olds the Goodenough Draw-a-Man Test (scored by the Goodenough System), the Peabody Picture Vocabulary Test, and the Gesell Copy Forms were given. For statistical analysis, I.Q.'s were derived from the Goodenough scores and correlated with motor scores. The 2 and 3-year-olds were given the Peabody Vocabulary Test and I.Q.'s were based on the scores (Table IV).

E. Maturity

To give further support in determining normality, the developmental status for 2's and 3's was established by the Gesell Development Examination. D. Q.'s were computed and correlated with motor scores; these were positive at .14 and .38, respectively (Table IV).

F. Reading Readiness

The Metropolitan Reading Readiness Test is used routinely in the Richmond Public Schools; the test scores were available for 6-year-olds. The correlation for these with motor score is given in Table IV.

G. Achievement

A teacher's estimate of achievement was obtained for the subjects in the final phase of the study. Scores were based on a 15-point scale in which ratings were made on five variables as good, average, or poor for ages 2 to 5. For 6-year-olds the teacher's comments and evaluation were similarly scored. See Table IV.

II. Movement Development Ages 2-6

The 25 movement tasks were scored for the 57 subjects at intervals of six months over a three-year period (in six phases).

A summary of the data for each age from 2-6 is given on pp. 14-26. For each age the presentation deals with successful performance, the elements involved, sex differences and selected characteristics of movement.

The means of the task scores are presented in Tables VII and VIII and in Charts 1-30.

The means of motor scores for each age, phase, and age group are given in Table IX; this table also shows the correlations with motor score and age at 2, 3, 4, 5, and 6 years. An analysis of motor scores by age and sex appears in Table V. Table VI presents time and distance measurements for jumping, throwing and running.

The incidence of the selected characteristics at the various ages is presented in Table X-XVII.

A. Movement Development at Age 2

At age 2 children are able to explore the world about them in an upright position and they can move freely from place to place. Their balance is facilitated by a wide stance and by outthrust arms. They pull, push, drag and carry objects with them in their play. Since falls are frequent the arms tend to be carried up and forward and thus are in readiness to break the fall when balance is lost. Vocabulary and experience are limited so telling must often be replaced by showing. Two-year-olds are eager to try new tasks but will refuse or change a movement task which they deem too difficult.

At age 2 the subjects in this study were successful in performing 16 of the 23 movement tasks assigned them (bouncing a ball and the figure-8-run were not included), i.e., in each of the 16 tasks more than 50% of the 2's performed successfully, and/or the mean score was 2 or better. They were especially proficient in carrying and creeping. Though he might be and in most cases was unsuccessful, the 2-year-old attempted to hit a ball and walk a beam; he executed his own version

of a gallop, a running high jump, a skip, and a slide. He seldom attempted a hop. Girls scored higher than boys in 15 of 23 tasks, but the difference in motor scores was small (girls 23.3, boys 23.1).

Selected Characteristics of Movement Tasks

1. All 2-year-olds demonstrated right hand preference in throwing and right foot preference in kicking, but varied in the use of hand or foot occasionally (with 10% frequency). See Table XVII.

2. They displayed opposition in vigorous running but this characteristic may or may not appear in walking (46% displayed) or in kicking a ball (50% exhibited). They are unlikely to use x-lateral synchrony in creeping or climbing or the foot-over-foot pattern in ascending or descending stairs. See Table X.

3. The 2-year-old maintains his balance by a slightly widened stance and by the use of his arms; these are usually homologous (except where in opposition as indicated above) and sideward or slightly forward. He can control his body on the bounce board but is unable to maintain balance on the 4-inch walking beam. See Table XI.

4. In rhythmic 2-part locomotion he may be able to gallop especially if he is an older 2, but the slide and skip are beyond him. His gallop will be with only one foot leading; the subjects were consistent in the choice of leading foot but evenly divided between left and right leads. See Table XII.

5. At 2 the child does not demonstrate effective total body assembly in hitting or throwing; he uses it occasionally in the standing jump down, but mobilizes his strength well in pushing (63%) and to a lesser degree in pulling and carrying. See Table XIII.

6. The 2-year-old responds visually and manually in catching successfully a large ball tossed to him and is sometimes (with 46% incidence) able to connect mallet or bat with ball when the ball is stationary. See Table XIV.

7. His agility is low as shown by the percentage of those executing the forward roll with a tucked head and rounded back (23%). See Table XVI.

8. At 2 the subjects usually displayed good body alignment and were able to adjust it in walking, running, and jumping. See Table XV.

B. Movement Development at Age 3

The period from 2 to 3 (the third year of life) is one of tremendous movement development. At 3 the child has progressed toward a more mature pattern in most motor tasks; he is larger, stronger, and more experienced. He is able to refine his movements and mobilize his body parts for more effective use. He can run faster, jump higher, throw harder - and objects and people no longer look quite so big to him. He can do all of the motor tasks he did at 2 and he is also able to (1) walk a 4-inch beam successfully and (2) gallop (76%) leading with the preferred foot; (3) he now performs the standing broad jump from a mark and usually with a two-foot takeoff and landing; he may be able to bounce a large ball several times (this was not tested at 3 but 63% were successful at 3½).

Selected Characteristics of Movement Tasks

1. Gain in dynamic balance was demonstrated by proficiency on the 4-inch walking beam (65%) and by a gain of 10% in success on the bounce board. See Table XI.

2. Improvement in x-lateral synchrony of 32% (age 2 - 23%, age 3 - 55%) in the creep and of 27% (age 2 - 3%, age 3 - 30%) in the climb were noted. At no other age was there such a marked change in this characteristic.

The 3-year-old ascends stairs (89%) and a ladder (55%) foot-over-foot but few descended stairs in this manner. The pattern of opposition had gained to 59% (from 46% at 2) in walking, but showed little change in running and kicking. Arms were more forward and elbows were bent to some degree in running. See Table X.

3. Rhythmic 2-part locomotion is demonstrated in the one-lead gallop (76%) and by some subjects (34%) in the slide and by a few (12%) in the skip. See Table XII.

4. Total body assembly is now used for speed in hitting (52%). Prevalence of total body assembly has also increased for pushing (from 63% at 2 to 83% at 3) and pulling (52% at 2 to 79% and 3). Gains were also noted for the two jumps and the carry but the incidence for these tasks was not above 50%. See Table XIII.

5. Agility, though not yet prevalent in the forward roll, was demonstrated by 35% of the subjects (a gain of 12% from 23% at 2). See Table XVI.

6. Eye-hand efficiency increased to 79% in catching (from 67% at 2) but showed only a small gain in hitting a ball. See Table XIV.

7. At 3 years postural adjustment in the selected activities showed little change from 2 although there was an 11% drop (from 73% at 2 to 62% at 3) in walking alignment. See Table XV.

8. Hand and foot preference were predominantly right with only four variations, in each case with the left foot. See Table XVII.

C. Movement Development at Age 4

The year from 3 to 4 was marked by further gains in size, strength, and motor effectiveness. Especially notable are the gains in rhythmic locomotion and balance, in method of decending stairs and in ability to jump over a bar.

At 4 the mean of scores of 21 of 23 movement tasks was higher than at 3 and the total means for the two groups differed by 11.1 points.

Inept in these tasks at 3, the 4-year-olds were able to slide, hit a stationary ball (58%), hop, and do the running high jump, and at 4½ years they were successful in the skip. They were able to bounce a ball (demonstrated by 63% at 3½ and 100% at 4 successfully). Only 13% could lead with either foot in the slide but 58% could do so in the gallop; only 13% could hop on the "other" foot. At 4 the subjects found

the 4-inch beam very easy and all were successful but the 2-inch beam was too difficult; they used their arms for balance and greater elevation on the bounce board. They were able to kick a rolled ball successfully and without loss of mean score. At 4½, 75% were successful in the figure-8-run with a mean score of 1.8 (up from 9% and a low mean of .5 at 3½). Boys forged ahead of girls in the standing broad jump and in throwing as evidenced by both motor scores and distance attained. Girls were slightly superior to boys in the running high jump and in the 50-foot run according to distance and time but boys were superior in method of performance as evidenced by task score. See Tables V and VI and Chart 19.

Selected Characteristics of Movement Tasks

1. Gains in dynamic balance were evidenced by a percentage gain in subjects demonstrating from 70-83 on the bounce board, from 65-100 on the 4-inch beam, and from 28-71 in the hop. See Table XI.

2. Gains in two-part rhythmic locomotion were apparent in the percentage increase from 76-92 in the gallop, from 34-77 in the slide, and from 12-52 in the skip. A gain from 14-58% was noted in ability to use either foot as a lead in the gallop and some preference for a right foot lead was observed. See Table XII.

3. In total body assembly the 4-year-olds showed gains for speed in throwing (from 24-48%), for power in the standing broad jump (50-64%) and the running high jump (45-80%), and for force in the pull (72-90%) and carry (48-84%). Losses of 17 and 12% were recorded for hitting and pushing. The ankle was used more often and more completely in jumping and running than at 3 but not with great frequency or consistency. The well bent elbow and lifted knee were also observed more frequently in jumping at 4 than at 3 but not consistently. See Table XIII.

4. In symmetry and opposition the 4-year-old showed greatest gains in using the foot-over-foot pattern descending stairs (12% at 3, 84% at 4). Other changes

varied from loss of 10% (55% at 3, 45% at 4) for two-point synchrony in creeping to a gain of 10% (55% at 3, 65% at 4) in foot-over-foot pattern in climbing a ladder. See Table X.

5. At 4 eye-hand efficiency had improved as exhibited in catching a large ball from 79% at 3 to 94% at 4, in hitting a ball from 48% at 3 to 58% at 4 and in bouncing a ball from 63% at 3 to 100% at 4. See Table XIV.

6. Agility as evidenced in the forward roll gained from 35% at 3 to 42% at 4 and also showed a gain from 0 at 3½ to 25% at 4½ in the figure-8-run. See Table XVI.

7. Postural adjustment remained high with percentage score gain in the walk from 62% at 3 to 77% at 4, in the run from 72% at 3 to 94% at 4, and in the standing broad jump from 76% at 3 to 81% at 4. See Table XV.

8. Right dominance prevailed with six variations. It is notable that the single evidence of left hand preference and mixed dominance at 4 years was resolved as consistent left preference for both hand and foot at 5 and 6. See Table XVII.

D. Movement Development at Age 5

Progress in movement development was paralleled by increased stature, strength, and experience and these provided a more knowledgeable and confident approach to the now familiar movement tasks. Greater challenge was added by providing a small ball (a tennis ball) for catching and a 2-inch beam for walking. Four movement tasks were measured in units of time or distance (Table VII). The bounce on the board was eliminated because of the greater weight of these children.

All tasks were performed successfully. In the performance of 19 familiar tasks there was a small gain in 8, a larger gain in 5, and a small loss in 4,

and the score at 5 years showed no change in 2. Sixty per cent of the subjects were successful in catching the small ball and the mean score was 1.9 thus evidencing a sharp drop from proficiency attained earlier with the large ball. Similarly, success fell to 56% (from 100%) and the mean score to 1.9 (from 3.2 at 4) with a decrease in the width of the walking beam from 4 to 2 inches. At 5½ the mean score was 2.4 in the figure-8-run and 3.6 in the ball bounce with 100% successful in the bounce and 80% in the run. See Table VIII and Charts 2 and 9.

Boys attained a major gain in the distance throw to a mean of 44.63 feet at 5½ while girls made a lesser gain to 25.07 feet. Gains were also recorded for the standing broad jump and running high jump with boys superior in the former and girls in the latter. Girls showed no improvement in the 50-foot run while boys decreased their time and bettered the mean of the girls slightly. See Tables VI and VII.

Selected Characteristics of Movement Tasks

Steady achievement in the selected movement charcteristics was typical of development from 2 to 4 and the rate of progress appeared as great but more varied from 4 to 5 years. Notable though erratic improvement was made in opposition and symmetry and achievement was evident in total body assembly, dynamic balance, rhythmic 2-part locomotion, and agility.

1. Gains were made in opposition of 4 to17% in the walk, run, kick, and skip. A small loss (1%) was noted in 2-part synchrony in creeping. See Table X.

2. Dynamic balance was demonstrated on the 2-inch beam at 56%; it increased in the hop by 25% (71-96%) and on the non-preferred foot by 83% (from 13% at 4 to 96% at 5). See Table XI.

3. Gains in 2-part rhythmic locomotion were indicated in the gallop by a 10% improvement in the use of the second foot lead; in the slide by a 23% gain of subjects successful and a 75% improvement in dual direction; and in the skip by a gain of 37% (from 52% to 89%) in successful performance. See Table XII.

4. In total body assembly some gains also appeared at 5: for speed in the hit from 35-60%, and in the throw from 48-68%; for power in the standing broad jump from 64-76%, and in the running high jump from 80-88%; for force in the pull from 90-92% and in the push from 71-76%. There was considerable loss (from 84-64%) in the carry. In running almost all subjects bent the elbows well; more than half (51%) contacted with the ball of the foot, and the lifted knee was used frequently but inconsistently. See Table XIII.

5. Agility also showed substantial gain as demonstrated in the forward roll by an increase in success of subjects from 42-64% and in the figure-8-run from 25-40%. See Table XVI.

6. Eye-hand efficiency was achieved in catching the small ball by 60%. In hitting there was a decrease in successful contact from 58-52%. (See discussion p.36 and Table XIV)

7. Postural adjustment gained in percentage demonstrating in walking, running, and the standing broad jump by 77-84%, 94-100%, and 81-96% respectively. See Table XV.

8. Right hand and foot dominance was prevalent with one subject consistent in left preference, one in left preference for hand and right for foot, and three (12%) exhibiting uncertainty or inconsistency. See Table XVII.

E. Movement Development at Age 6

Mean scores of subjects at 6 indicated success in each of 24 movement tasks.

Mean task scores ranged from 2.1 to 4.3 with a mean motor score of 60.9. Examination of the scores shows some loss in seven of the 24 movement tasks. The number of successful subjects increased notably in the beam walk (56-77%) and in batting a ball (52-78%), while mean scores showed marked improvement (.5 or more) in climbing, descending stairs, the figure-8-run, galloping, hitting, skipping, sliding, throwing, and walking a beam. Those tasks in which losses of .5 or more occurred were the forward roll (3.1 - 2.6) and pushing (4.1 - 3.4); mean scores for other movement tasks remained the same (1 motor task), showed slight gains (7 motor tasks) or losses (5 motor tasks). See Tables V-IX and Chart 30.

At this age sex differences became more apparent; the correlation of motor score with male sex was notably higher (.41) than at previous ages. The most obvious difference between the sexes was in throwing where the mean distance varied from 31.91 feet for girls to 57.37 feet for boys, and the mean motor score on the throw from 3.0 for girls to 4.6 for boys. Boys surpassed girls in all of the four measured events and in mean motor score (boys = 64.0, girls = 57.7). Means for distance in the jumps and throw showed improvement over previous scores. Although the mean of time for the 50-foot run was less than at 5½ (4.58 - 4.19 sec.) it compared unfavorably with that at 5 (3.48 sec.). (See discussion pp. 40 and 51-52.)

Selected Characteristics of Movement Tasks

Improvement in the selected characteristics from 5 to 6 years was rather erratic. In 29 variables checked for the seven characteristics, 21 showed gains, seven losses, and one was unchanged. Gains were consistent in dynamic balance, two-part rhythmic locomotion, and in total body assembly for speed and power.

1. In x-lateral synchrony in creeping the gain was from 44% at 5 to 56% at 6; in use of the foot-to-foot pattern in descending stairs there was a small gain from 92-94%. In opposition there were gains in the run (91-100%) and skip (16-44%), but no change in the walk and a loss (72-55%) in the kick. (See discussion pp. 37-38 and 43-44 and Table X.)

2. In dynamic balance improvement was notable (56-77%) on the balance beam and reached 100% (from 96% at 5) for the hop and the use of either foot in the hop. See Table XI.

3. In 2-part rhythmic locomotion the 6-year-olds were 100% successful in the performance of the skip and in the slide with either right or left foot leads; they also showed improvement in the gallop (from 88% at 5 to 89% successful at 6, and from 68% at 5 to 83% at 6 with either right or left lead) but some confusion was also exhibited. (See discussion p. 35 and Table XII)

4. Total body assembly was apparent as a developing characteristic for speed in hitting (from 72-88%) and throwing (from 76 to 83%), for power as demonstrated in the standing broad jump (from 76-83%), and running high jump (from 88-94%) and for force as exhibited in the pull (92-100%) and push (76-100%). There was a retrogression in the carry (64-61%). In running the range of action at the knee showed little change but there was less use of ball-of-foot contact. See Table XIII.

5. The characteristic of agility gained a little (from 40% at 5 to 44% at 6) in the figure-8-run but less was evident at 6 than at 5 in the forward roll (64% at 5 and 41% at 6). See Table XVI.

6. Greater eye-hand efficiency was demonstrated in catching (from 60% at 5 to 72% at 6) and in hitting (41 (52-78%), but two subjects were unsuccessful in the ball bounce (100 to 0.7 See Table XIV.

7. Postural adjustment was less satisfactory at 6 than at 5 with a drop in the walk (from 84% to 67%), the run (from 100% to 89%), and the standing broad jump (from 96% to 89%). See Table XV.

8. Right dominance of hand and foot was clearly demonstrated by all except three (16-2/3%) of the 6-year-old subjects. Of these three, one was completely left dominant, one was mixed (LH-RF) and the third still evidenced uncertainty. See Table XVII.

III. Selected Movement Characteristics

In order to test the selected characteristics as indicators of movement development they were studied in relation to motor score. Those having correlations with motor score at or near a 5% level of significance are presented in Table XVIII. To determine whether the independent variables under study produced significant effects the Multiple Linear Regression Analysis (Bottenberg and Ward, 1963) was utilized; a full model was constructed for each age level of several of the variables (see Table XIX) correlating at or near the level of significance with the motor score; the correlations of these models with motor score ranged from .720 at age 3 to .925 at age 5 (Table XIX). Each of these variables (characteristics) was then restricted from the full model one at a time to test its contribution to the full model and to determine the probability of its contribution as significant. The findings are summarized for each age level. See Table XX.

At age 2 the characteristics showing highest correlation with motor score were dynamic balance (as demonstrated on the four-inch beam) and total body assembly for strength as demonstrated in pulling and carrying and for power as evidenced in the standing jump down. Other characteristics above or near the significance level were rhythmic locomotion, opposition, and total body assembly for speed. When the highly correlated characteristics were submitted to a covariance analysis, only the beam walk (probability .011) and pulling (probability .048) proved to contribute significantly ($P. < .05$) in prediction of motor score.

At 3 the characteristics showing highest correlation with motor score were dynamic balance in hopping, rhythmic locomotion in sliding and galloping, and total body assembly for power in the high jump. Other characteristics above or near the significance level were total body assembly for speed and force, symmetry in foot-over-foot climbing, postural adjustment in walking and eye-hand efficiency in catching. No one of these proved to contribute to motor score at 5% level of confidence.

Those movement characteristics which showed highest correlation with the motor scores at 4 were x-lateral synchrony in climbing, total body assembly in the standing bread jump, rhythmic locomotion in skipping, and total body assembly in hitting. Others at or near the significance level were dynamic balance, eye-hand efficiency in catching, and other evidences of total body assembly, rhythmic locomotion and opposition. As single predictors of motor score, four characteristics were judged significantly useful -- total body assembly as demonstrated for power in the standing broad jump (P=.037) and for speed in the throw (P=.029), rhythmic locomotion as demonstrated in the skip (P=.011) and opposition as used in kicking (P=.025).

Those movement characteristics showing highest correlations with motor scores at age 5 were foot-over foot pattern in descending stairs, dynamic balance on the walking beam, total body assembly in pushing and eye-hand efficiency in catching a small ball. Others above or near the level of significance were total body assembly for power, rhythmic locomotion, agility and eye-hand efficiency in hitting. In seeking a single characteristic as predictor of motor score, three were found to have significant probabilities -- dynamic balance on the two-inch beam (P=.011) rhythmic locomotion in the skip (P=.014) and eye-hand effi iency in hitting (P=.022).

At six the movement characteristics most highly correlated with motor score were postural adjustment in the walk, agility in the figure-8-run, total body assembly in hitting, and dynamic balance on the two-inch walking beam. Of these, postural adjustment in the walk was judged (P=.003) to have significance as a single predictor of motor success.

IV. Individual Differences - Ages 2-6

The range of scores (Table XX) indicates much variation in success and in characteristics of movement tasks from age to age and also within age levels. Scores of 0 appear at 2 for all movement tasks except walking and throwing, but only in three tasks do all 2-year-olds score 0 - hopping, skipping, and sliding. Scores of 0 appear at age 6 for nine tasks; an examination of the scores for individuals reveals that, with one exception, each subject scoring 0 on a movement task at six had previously scored 2 or better on that task (the exception, a male, scored 0 in hitting at all ages).

Variation in motor characteristics also occurred at all age levels and for individuals at various observations. For example, opposition was demonstrated by eight subjects at two in walking but only three of these used it at 2½.

In case studies (see Appendix IV) the mean motor score of each subject was compared with the mean score of his age group for each phase of the study; in addition, the task scores and activity analysis sheets were studied for each individual to detect marked deviations in performance (Tables XXII and XXIII).

Variation from mean score of the age group ranged from -14.9 to +19.5. Boys and girls were found in high and low extremes in equal numbers; in the higher range the subjects were often among the older ones in the age group; they appeared to excel in almost all tasks at all age levels. Conversely, the younger children often scored low consistently; after age two, boys in this group appeared to have more persistent problems than girls. Some subjects in the low

scoring group fluctuated from phase to phase; they tended to make low scores in all tasks but deficiencies were noticeably frequent in balance activities (the walking beam and hopping) in eye-hand efficiency (especially in catching), and less often in rhythmic locomotion (galloping, sliding, and skipping) and total body assembly for power. The abilities evidenced by these characteristics appear to contribute significantly to the child's movement development as evidenced by correlation with motor score (Table XVIII).

Dramatic improvement sometimes occurred as for the subject who gained in motor score from 32 at two to 66.2 at 2½, and for another who gained from 41 at 4½ to 66.2 at five. Losses of this extent were not recorded but drops did occur of up to 18 points from one testing period to another.

V. Movement Patterns

Movement pattern is defined as a coordinated movement of body parts used involuntarily to achieve a certain objective. The pattern, though non-volitional by definition, may emerge in toto or be developed over a period of time; during the period of development the subject may or may not be using wilful action.

In this study no effort was made to involve volitional control of movement; rather emphasis was placed upon the goal to be achieved; since the subjects were young and inexperienced it is probable that movement patterns observed were those which emerged in the conscious effort of the subject to achieve his purpose.

For each motor task the analysis form (see sample in Appendix II) included those elements believed to make up the mature movement pattern of a normal but not highly trained subject. These are listed for each task (pp. 28-45) and the standards for success and mature pattern are stated.

1. Ascending stairs

Elements of the task:

Foot over foot	Arms move forward-backward if at all
Opposition	Climbs in a straight line
No support	Rhythmic and even
Body faces forward	Body well aligned

Preference for R or L indicated by leading foot

The child is deemed successful if he ascends the stairs without resorting to all fours.

The pattern is judged mature if the foot over foot pattern is attained and there are no marked deviations.

As evidenced by mean scores subjects were successful in climbing stairs without support at 2 and had attained a foot over foot pattern at 3; at 4 and after improvements occurred especially in balance, relaxation of arms, and in rhythm and steadiness of progress.

2. Bouncing (on a board)

Elements of the task:

Maintains balance (4-10X)	Uses arms in elevation
Number of successive bounces to 10	Uses ankles in flexion-extension
	Arms pause at or above shoulders
Increases height	Rhythmic and steady

The subject is deemed successful if he achieves 4 successive bounces without help.

Mature pattern consists in use of the arms in elevation and if there are no marked deviations.

Mean scores indicated success on the bounce board at 2½ years; continuity and steadiness of balance with elevation of the arms leading the jump are indicated by a mean of 3.1 at 4.5 years. Very rarely did children of these ages lift and hold the arms in suitable timing for really high bounces. Many achieved increasing heights at 4 and a few at 3. The ankle was used by some subjects from 2 and by most by 3½ but there was much variation. This task was not used for 5 and 6 year olds.

3. Bouncing a ball (large ball)

Elements of task:

One hand used (R or L)	Starts with both hands
Knee-to-waist height	Moves with ball
Moderate speed	Covers space

Subjects were deemed successful if they were able to control the ball for four or more successive bounces. The mature pattern consisted in achieving six bounces and covering space at a walk or four bounces if space was covered with a run provided there were no marked deviations.

No record was made for ages below 3.5 years in ball bouncing; success was attained with a mean score at 2.8 at 4.5 years. At age 5.5 years the movement pattern met the standards of maturity. With few exceptions the subjects started with both hands and maintained bouncing with the right hand.

4. Carrying (weights ranged from 8-20 pounds)

Elements of the task:

Bends knees to pick up	Moves in direct path
Keeps object close to body	Moves at steady pace
Supports weight off floor all the way	Trunk erect except compensation
	Controls weight in putting down
Compensates in shift of body	Uses one hand (R or L)

Success consisted in supporting weight the full distance. The mature pattern was established when the subject was successful using one hand the entire distance (suitcase styles) and with no marked deviations.

Two-year-olds achieved success and an efficient pattern in carrying a box and small weighted suitcase. The subjects lifted and put down with bent knees, held weights close to the body, compensated with shift of body weight, and occasionally gave additional support with some part of the body (chest or thigh). They sometimes used both hands and occasionally dragged the object to the designated goal.

As the children grew older and stronger they were able to carry heavier weights and used both hands less often.

5. Catching (large ball 2-4 years; small ball 5 and 6 years)

Elements of the task:

Catches 2 of 3 trials	Catches with 1 or both hands
Places hands in readiness	Gives to lessen impact
Lateral stance or adjusts feet	Eyes opened and focused
	Uses reaction of catch for return

Success consisted of 2 catches in 3 tries. If in addition the subject used his hands and did not cradle the ball in his arms or against his body he was judged to have attained the mature pattern.

Success in catching with a mean score of 2.1 was attained at 2.5 years with a rubber playground ball accurately tossed. The arms received the ball as a cradle and in most instances were placed in readiness in advance of the throw; the ball was sheltered by the chest as arms hugged the ball; improvements consisted of adjusting position to meet the ball and a gradual transfer of receiving from arms and chest to hands and arms and then to hands only; catching with the hands alone was achieved infrequently except with the small ball (used at 5) and inconsistently with it until the age of 6. Stance was usually square; although some relaxation of hands and arms lessened the impact of receiving it was not extensive and in no case was it translated into direct preparation for the returning throw.

6. Climbing

Elements of the task:

Uses arms in alternation	Climbs to the top
Uses foot over foot action	Body faces ladder
Uses x-lateral synchrony	Steady and rhythmic
Preference for R or L indicated by leading foot	

If the child climbed until his feet were on the second rung from the top of the ladder he was judged successful. If in addition he used a foot over

foot action and exhibited no marked deviations the mature pattern was considered to be demonstrated.

Climbing has been likened to creeping since both arms and legs give support and propulsion. This task was approached eagerly by all ages; at age 2 most subjects reached the top of the 66-inch ladder and at age 3 the majority attained the top of an 8-foot ladder. The foot to foot method was commonly used until age 3 and sometimes thereafter; order of movement with the younger children was most often 1st hand, 2nd hand, 1st foot, 2nd foot with variation from homolateral to cross-lateral. At 3 or whenever the foot over foot pattern was established movement became oppositional but not always synchronous; i.e., the hands often moved ahead of the cross-lateral foot rather than in synchrony with it thus making a four-part rather than two-part movement. Occasionally the hands were observed to move together and preceding the alternating foot action. At all ages the children faced the ladder and maintained the trunk in proximity. Variations in speed, rhythm and steadiness appeared as individual more than as age differences. Fear was seldom evident and the subjects descended the ladder without help. As a safety precaution an aide always stood near.

7. Creeping

Elements of the task:

Uses arms alternately	Points hands forward
Uses legs alternately	Keeps feet off floor
Uses limbs in opposition	Keeps back level
Uses cross-lateral synchrony	Controls direction

Success was achieved if the child covered the expected distance on hands and knees (or feet). If he used his limbs in opposition and there were no marked deviations the mature pattern was considered to be achieved.

Success was attained with a mean of 2.9 at 2 and 3.6 at 2.5. Gains thereafter were slight with small and varying changes to age 6. At 2 the

movement pattern was characterized by alternation and opposition of hand and foot; cross-lateral synchrony was less common than the four-part movement of hand-foot-hand-foot. Cross-lateral synchrony increased among threes and fours but was not demonstrated by a majority at any age. Dragging feet, rounded backs, and distortions of leg action appeared as individual deviations not related to age.

8. Descending stairs

Elements of the task:

Foot over foot action	Arms used in opposition
Uses no support	Descended in straight line
Body faces forward	Rhythmic and even
Arms used for balance	Body well aligned

Preference for R or L indicated by supporting foot on descent

Success was achieved by descending in the erect position without help. Mature pattern was gained in the use of foot over foot action without obvious defection.

Two-year-olds descended stairs in an upright position and most did so without support. They used the foot to foot method and tended to lead with the non-dominant foot reserving the other for support; eyes focused on the step below; arms were widespread and somewhat stiff. If the steps were wide or high the subject turned slightly away from the leading foot, otherwise his path was straight. Symmetrical and oppositional use of arms and legs develop gradually; the foot over foot pattern was used at 4 or 4.5; the arms were always used for balance and occasionally in opposition at 3, 4, and 5; at 6 fifty per cent exhibited opposition but some allowed the arms to hang at the sides as though not needed for balance. At six the subjects descended with confidence, rhythm and easy speed.

9. Figure-8-run

Elements of the task:

Starts promptly
Runs 1st to own R
Alternates direction
Maintains balance
Maintains speed
Stays close to obstacles
Uses arms for balance
Follows course
Shows evidence of motor planning

The subject was deemed successful if he covered the course in any order. He was judged to have demonstrated mature pattern if he completed the circuit with one or more cross-overs and with maintained balance and speed.

The figure-8-run was first introduced at age 6 and later used with younger subjects at 3½, 4½, and 5½. It involves motor planning to a degree beyond that required by any other task used in the study. It seems probable that success may depend upon listening, comprehending, and planning rather than upon agility and other characteristics and elements more commonly associated with movement tasks. Some success was attained at all ages and by more than 75% at 4½. Fifty per cent were able to follow the course at age 6 but few children alternated directions in following the figure 8's. At all ages subjects maintained balance, stayed close to objects on the turns, and started promptly on a signal. About half maintained speed but movement was never really rapid.

10. Forward roll

Elements of the task:

Hands point ahead
Uses hands for partial support
Tucks head
Rounds back
Flexes knees and hips
Rolls straight
Comes to feet from roll

Success was judged accomplished if the subject went over. Mature pattern was judged achieved if the head was tucked and the back rounded.

For the forward roll two movement patterns were observed as comfortable and satisfying for the performer -- the tuck and the pike. Unsuccessful subjects placed the head on the mat, maintained a rigid neck and back and failed to go over or, though in a rolling position, veered so far to the side as to preclude the roll.

Most 2's were successful with rounded back and shoulders, but only half of these maintained forward direction. All pointed hands forward and used them for partial support and those who rolled straight maintained this hand position. Improvement from 2-6 was individual rather than by age and failure and/or discomfort tended to persist. As the child grew older he tended to maintain the tucked position for a longer time rather than unfolding immediately after the roll over, but in no instance did a subject roll to his feet. Improvement consisted of maintaining a closer tuck, adding momentum and maintaining direction but these characteristics were not well established at any age studied.

11. Galloping

Elements of the task:

One foot leads (R or L)	Rhythmic and steady
Faces forward	Uses arms in balance
Can change lead foot	Staccato movement

The subject was deemed successful if he maintained a recognizable gallop. Mature pattern consisted in demonstrating the gallop in a steady rhythm with no marked defect.

The pattern of the gallop appeared at 2 and was prevalent among the older two's and three's. The subjects faced in the direction of the leading foot and brought the following foot up to or slightly beyond it in a staccato and accented rhythm; in some cases the movement was high and prancy, in others close to the ground and distinguished only by its uneven rhythm. The

leading foot was consistent at 2 and 3 but preference was evenly divided between left and right; at 4 and after preference was for the right though from 4½ the subjects were able to lead well with either foot. Most subjects attained a steady rhythm with their first success but when arrhythmia was present it tended to persist. At all ages the arms were used for balance and generally both arms were moved forward with the leading foot.

12. Hanging

Elements of the task:

Assumes position without help	Head and shoulders normal
Uses overgrasp	Arms straight
Holds position 4-20 seconds	Gets down without help

Success consisted of supporting own weight by hands in hanging position for at least 4 seconds. Mature pattern was judged attained if the subject maintained the hanging position for ten seconds with no marked deviations.

Two-year-olds are able to support their weight for four seconds when grasping a bar though they may need assistance in getting to and from the bar. Duration increased to ten seconds at 3 and to twenty seconds at 5 and above and at 4 and after no assistance was needed. At all ages the subjects used an overgrasp and the arms were straight. At 2 most subjects allowed the shoulders to move up and the head forward; at other ages about half maintained a normal position of the head with a slight retraction of the scapulae.

13. Hitting

Elements of the task:

Contact in three trials	Uses body rotation
Sideward stance	Controls direction
*Shifts weight in preparation	*Follows through
*Shifts weight in hitting	Contacts ball squarely
	Hits R-L (or L-R)
	Uses both hands

Success consisted in hitting the ball. Mature pattern was demonstrated with a real transfer of weight (at least 2 of the starred elements).

In considering pattern for hitting both success (contact with the ball) and method must be evaluated and the subject's goal might be a determining factor. If he concentrates on merely contacting the ball there will be little need to practice total body assembly but if he attempts to hit the ball hard ("like a baseball player!") he may utilize total body assembly but miss the ball! In this case the investigator tried to elicit the pattern for the hard hit. The bat (or mallet) was usually held in both hands at 2 and consistently thereafter. A preference for right to left hitting was evidenced at all ages but there was some inconsistency in individual preference at all ages below 6.

A sideward stance was not used by the majority of subjects until 4½ and after; similarly a preparatory shift of weight was in common use at 4 and after. A shift of weight was often used with the hit at 2 and usually thereafter; body rotation was prevalent at 4 and after though the follow-through was not in common use until 6. Boys were more advanced than girls in stance, shift of weight, body rotation and follow through. Only at 6 did a considerable number of subjects (50%) contact the ball squarely. At this age 4 of the 9 boys failed to contact the ball although they swung mightily.

14. Hopping

Elements of the task:

Hops at least four times in succession	Holds free foot up to rear
Hops in straight line	Uses arms for balance
Hops on preferred foot (r or L)	Uses arms for symmetry
	Hops with either R or L foot

Success is attained with four successive hops, mature pattern with 6 hops (or completed distance) if the free foot is held up and to the rear.

Success in hopping (4 hops on one foot) was attained by the majority of subjects at 4 and by all at 4½. With little practice the subject was able to improve in duration and distance. Increasing skill stabilized the free foot to the rear with a bent knee (nearly all subjects, most from first success) and offered a choice of feet at 4½ and after. Arms were used in a symmetrical forward movement with the advancing foot. Although some practice is necessary for use and grace the mature pattern seems to appear in toto. At the earlier ages there is a definite foot preference, evenly divided at 3 when evident and more often for right support at 4 (67%).

15. Kicking (ball stationary at 2 and 3, rolling 4-6)

Elements of the task:

Moves toward ball	Uses R foot (or left)
Contacts ball with foot	Extends knee in kicking
Times backswing for kick	Contacts ball squarely
Uses limbs in opposition	Controls direction

Moves in direction of kicked ball

Success was credited when foot contacted ball and the ball moved forward its full circumference or more. Mature pattern required opposition with the kick except for a lifted kick when both arms moved forward-sideward in balance; in addition the ball was to be kicked from a backswing or in the stride of the run.

Success was achieved at all ages except by a few of the youngest two-year-olds; direction was predominantly forward but with much deviation to left or right; earlier trials included a running approach to a placed ball with a stop or run-through for the kick; limited preliminary backswing was common at 2 and 3 but was neither prevalent nor vigorous until 4 and thereafter; the rolled ball was introduced at 4 and the subject ran forward to meet it. There was a consistent preference for the right foot, demonstrated at 2 and thereafter at or near 90%. Opposition of arm with kicking foot occurred

irregularly at all ages and most frequently (67%) at 5; as the older child began to lift his ball the arms tended to spread sideward. There was much variation in contact of foot and ball and consequently in direction. Knee and ankle were usually extended in the kick; approximately half of the 5 and 6-year-old subjects moved forward in follow through after contact.

16. Pulling

Elements of the task:

Moves obtacle the full distance	Uses legs and/or arms
Hands placed in "pull" position	Keeps contact with object
Exerts force in line with resistance	Applies force steadily after start
	Controls direction
	Adjusts body

Uses wide, open stance at start

Success was attained if the obstacle (bench with rider) was pulled the full distance. Mature pattern consisted of success with body adjustment and no marked faults.

By experimental and trial-and-error methods success was attained by most subjects at the earliest age (2). Body adjustment occurred from the beginning, but mean score did not reach 3 until the age of 4. Greatest difficulties were in maintaining traction with the feet and in maintaining momentum after starting. The most commonly used method consisted of a succession of tugs, each started with the feet together, the body flexed at the hips and the hands holding the sides of the bench near the end. Improvement, noticeable at 4 and occurring inconsistently thereafter, consisted in walking backward and continuous pulling in order to maintain momentum.

17. Pushing

Elements of the task:

Moves obstacle the full distance	Uses legs and/or arms
Places hands in "push" position	Keeps contact with object
Exerts force in line with resistance	Applies force steadily after start
Adjusts body	Controls direction
	Uses wide, open stance at start

Success was attained if the object (bench with rider) was pushed the full distance. Mature pattern was judged as success with body adjustment and no marked faults in performance.

As in pulling experimentation and persistence earned success at 2; gains thereafter resulted in maintaining movement by keeping the hands in place and moving forward with continuous application of force. The hands grasped the sides of the bench near the end; usually knees, hips, and trunk were flexed to bring the pushing force more in line with the resistance but, instead, a few subjects brought the thighs in contact with the bench and "walked" it forward; the latter method lessened the difficulty of maintaining foot traction while overcoming stationary inertia; in the former and more frequently used method the starting stance was open with one foot well advanced. There appeared to be little change in movement pattern after 2½ but perhaps some gain in the 'know-how" for using it.

18. Running

Elements of the task:

Covers the full distance	Elbows are well bent
Inclines body forward at start	Lifts knees well in front
Symmetry in leg action	Controls direction
Symmetry in arm action	Toes point ahead
Uses limbs in opposition	Uses ball-of-foot contact

Success was achieved in running the distance. Mature pattern was identified by the use of opposition.

The pattern of the run at 2 is characterized by short strides, stiffness in the knees, widely spaced feet, and arms spread sideward even though they may be used in opposition (by 80% if the running is vigorous). The body is inclined forward in the start at all ages but the inclination is less at 2 and 3; some children tend to lean from the hips throughout the run. Opposition is firmly established at 3 and arms gradually assume sharp flexion at the elbow with a shortened piston-like swing at 5 or 6. Strides are lengthened and some but not all subjects will use the high knee lift at 4, 5, and 6. A few children used the ball of the foot for contact at 2, 3, and 4 and 51% did so at 5 but this pattern was not maintained at 6. (Incentive for running fast seems to motivate patterning for speed, i.e., lengthened stride, well-bent elbow, ball-of-foot contact, etc.)

19. Running high jump

Elements of the task:

Clears the bar in a leap or jump	Uses arms(2) for elevation
Checks run on approach	Accelerates opp. arm with trailing foot
Takes off from 1 foot (R or L)	
Lowers center of gravity over bar	Lands on 1 foot (R or L)
Controls landing (legs, arms, or roll)	

Success consisted in clearing the bar at any height. Mature pattern consisted of success with take-off preceded by leading elevation of both arms and no marked faults.

A true jump (or leap, since transfer of weight is usually from one foot to the other) was usually achieved at 3½ or 4 and from 4½ the mean score was 3 or better. The run is checked and both arms are elevated for the take off; the trunk is usually upright and facing forward; the leading foot is lifted high and the trailing leg is flexed at the knee to avoid the bar. The right foot was used for take-off by 72% of the subjects at 3 and with decreasing frequency to 33-1/3% at 6. Forward and/or upward accerleration

of the arm in opposition with the trailing leg occurred from 3 on but only occasionally. Similarly a subject occasionally lowered his trunk when over the bar enabling him to gain height with the lower portions of his body; this occurred rarely at 3 and thereafter and most often (by 25%) at 6.

20. Skipping

Elements of the task:

Covers the prescribed distance	Uses ball of foot
Alternates feet evenly	Moves in direct path
Uses arms for balance	Rhythmic and steady
Uses limbs in opposition	Shows no difference R and L

Success required at least 4 successive skips. Mature pattern was attained when success was demonstrated over the prescribed distance and skipping was steady and rhythmic.

No subject was successful before 2½ and few children were successful before 4; almost all could skip at 4½; the pattern emerged in almost complete form but was sometimes preceded by the "one foot skip". For some children practice was needed in order to attain the steady rhythm indicated by the mean score of 3.1 at 6 but some demonstrated this requisite for mature pattern much earlier. Occasionally the skip was done on the ball of the foot but even then the action was intermittent. Both arms lifted with the hop or were used inconsistently until 5½ or 6 when opposition was employed by about half of the subjects.

21. Sliding

Elements of the task:

4 or more successive slides	Controls direction
Maintains body facing forward	Rhythmic and steady
Leads with one foot (R or L)	Can lead with either foot
Uses arms for balance	Can change direction

Success consists of 4 or more slides with right or left foot leading.

Mature pattern is considered to be success over the prescribed distance with steadiness and consistent rhythm.

At age 4 success was achieved with a mean score of 2.4. The requisites for mature pattern were attained by girls at 5 and by boys and girls at 5½ as evidenced by a mean score of 4.6. Although all of the subjects could lead with either foot and thus slide to right or left at 5 and many could do so at 4, there was obvious superiority with the preferred lead until 6 when no difference was observed.

22. Standing broad jump

Elements of the task:

Covers space forward	Synchrony in arms
Takes off from mark	Uses 2-foot take-off
Uses arms in preparation	Bends knees well in preparation
Uses arms forward, upward direction	Controls landing forward
Accelerates with legs in air	

Success consisted of using a true jump (2-foot take-off) to cover space. Mature pattern consisted of success with the arms leading in paired movement.

Success was achieved at 3 and the mature pattern at 3½.

Two-year-olds were unable to manage a 2-foot take-off from a mark but could do so from an elevation. Some subjects demonstrated at 2 all other elements listed for the pattern except leg acceleration. In this task mature pattern is acquired early, persists, and shows relatively little change from 3 to 6. The thrusting acceleration of the legs in midair appeared at 4, more often at 5 and was demonstrated by 61% at 6.

23. Throwing (small ball)

Elements of the task:

Projection of the ball	Uses overarm throw
Sideward stance	Is consistent in style
*Shifts weight in preparation	Controls direction
*Uses body rotation	Follows through
Throws with R hand (or L)	*Cocks and uses wrist

Success consisted of projecting the ball in a forward direction. Mature pattern was judged to be the use of 2 or more of the starred elements thus showing mobilization of several levers in a sequential summation of force for speed and distance.

Success was attained at 2 and usually by an overhand throw in which the thrower faced forward, brought the ball up to and near the shoulder, hyper-extended the trunk and threw the ball by upward and forward movement; in many cases the subject moved into a wide forward-backward stride allowing a rocking movement over the legs and strong trunk flexion in the projective phase and follow through. The sideward stance was characteristic at 3 and 4, most boys and some girls shifted weight backward in preparation and forward in projection; they also used body rotation both in preparation and projection; a true follow through with strong body rotation and forward step was not common until 6. Only a few children used the wrist (a combined action of humerus and radio-ulna rotation with wrist flexion) giving additional speed to the ball;[3] these were 5 or 6 years of age and all were boys.

24. Walking

Elements of the task:

Covers the distance	Uses limbs in opposition
Alternates legs symmetrically	Toes ahead
Uses arms symmetrically	Walks in straight line
Uses arms for balance	Heel strikes ground first

Body is well aligned

Success consists in covering the distance with a walk (small children often prefer to run!). The mature pattern was defined as symmetrical use of arms and legs with no marked faults. Success was attained at 2 and the mature pattern at 3.

The younger 2's are still uncertain in balance and therefore they walk with feet apart and arms sideward-forward. Both knees and elbows are

[3]Glassow and Cooper, Kinesiology.

stiff. If highly motivated the subject accelerates his pace and may fall forward especially if he stops suddenly. In this study the children walked with toes forward at two and later although there were exceptions (in-toeing with both feet which persisted in three subjects and out-toeing usually with one foot only). At 3 balance was improved, arms were closer to the sides and beginning to move oppositionally, stride was lengthened, knees were "easy" and the heel-toe contact was well established. By 4 the subject no longer needed his arms for balance; if the child was relaxed and comfortable they hung loosely at the sides, swinging in opposition when the walk was vigorous.

Carriage was erect at all ages with exceptions which in most cases were only occasional for the individual.

25. Walking the beam (4" width ages 2-4; 2" width ages 5 and 6)

Elements of the task:

Walks full length (8')	Moves forward continuously
Keeps feet on beam	Moves forward at steady pace
Uses arms for balance	Uses arms in opposition
Toes ahead	Eyes focus ahead

The subject was deemed successful when he walked the full length of the beam with not more than one step off. Mature pattern was judged attained when the subject moved forward toeing ahead and using arms for balance as needed.

Success was achieved with a mean score of 2.3 at 3; the mature pattern was established at 4 on the 4-inch beam with a mean score of 3.2.

Two year olds approached the walking beam with interest and confidence. Usually they moved forward steadily even though some steps were off the beam. As at later ages the child placed the whole foot on the bar, toe pointing forward, and he faced forward with eyes focused on the beam a foot or two ahead. At this age and later the subject raised his arms sideward for

balance; at 3 he made greater effort not to step off the beam and a majority were successful in walking the full length. At four the subjects were able to walk the 4-inch beam easily and at a steady pace. When the 2-inch beam was introduced at 5 difficulty was experienced, but the subject was more adept then before at regaining balance. Only on one or two occasions did a child use hand-foot opposition on the beam and rarely did a subject focus ahead at eye-level rather than down. Gains in skill occurred from 2-4 on the 4-inch beam and from 5 to 6 on the 2-inch beam but the movement pattern changed very little.

Chapter IV

Summary & Discussion

1. Children do progress in their ability to move. Their progress is demonstrated by increases in the speed, force and power which they are able to generate and by the developing complexity of their movement; more important perhaps they are more able to cope with purpose and a variety of goals as indicated by their developing mastery of their own bodies and of the factors of time, force and space.

This progress in movement appears to emanate in part from the growth and development of the neuromuscular system to a point of readiness which manifests itself on a predictable time table if the opportunity and motivation are provided to elicit it; in addition it appears that this progress or development in movement requires effort and practice in a favorable environment with goals which are appropriate and interesting to the child.

It may be assumed that neuromuscular readiness is conditioned by growth and development of related body systems (as the skeletal) and by the integrity and development of the sensory mechanisms, or as pointed out by Chaney and Kephart[4]

[4]Chaney and Kephart. Motoric Aids to Perceptual Training: Preface.

and also by others, that it is one aspect of the total and complex development of the individual.

2. Movement development is positively related to increasing chronological age. The variation of motor score with age may be expected at all age levels but a difference of a few months is of less significance at 4 and after than at 2 and 3. When children are classified in age groups teachers and parents should be especially aware of age differences within the groups. A child of 6 in October may have abilities more like those children in the age 5 group than like those of the other 6's, and a late 3-year-old may be far ahead of another child who is just past 2. Conversely, a child of nearly 6 on October 1st may find the tasks offered the 5-year-olds very easy and lacking in challenge.

3. There is much variation among pre-school subjects in movement development. Wide deviations from the mean as attested by large standard deviations and varying ranges of motor scores marked the performances of all age groups and many individuals.

Rank by age within the age group appeared as a very significant factor in placing a subject among the highest or lowest in his group. Characteristics having evident importance in such placement included (a) dynamic balance, (b) eye-hand efficiency, (c) total body assembly, and (d) rhythmic locomotion.

In evaluating a child's movement development consideration should be given to the number of tasks in which he appears retarded or accelerated and to the degree of this retardation or acceleration. In addition the performance of the child should be studied to identify the specific tasks and to note the absence or presence of the pattern elements and selected characteristics. These quantitative and qualitative judgments when considered with age, sex, and other known factors may enable a parent or teacher to identify those children for whom special help is needed.

Children in need of prolonged remedial programs are usually deficient in a large number of tasks or show a marked and consistent insufficiency in two or more tasks or characteristics. For most deviations a little help given at the right time can be expected to bring effective results.

4. Movement prowess tends to be greater for girls at ages 2 and 3 and for boys from 4-6.

Sex differences appear in several motor tasks with girls having some advantage in jumping, rhythmic locomotion, and balance tasks, and boys in catching and in those tasks requiring strength and speed; the greatest difference occurred in throwing and was manifested in the definite superiority of boys from age 3. Other sex differences were more often exhibited at age 4 and later than at 2 and 3. Social environment may account in part for these sex differences as has been suggested by Hicks[5] and others, but sex-linked genetic influence must be suspected especially when the disparity is so great and so persistent as in throwing.

5. Young children of the black race appear to have some advantage over white children in motor performance. Consistent negative correlations with white race were found indicating for the dichotomous variable of race equal positive correlations with black race; for each age the r is below the established level of significance so the evidence here is not conclusive.

6. Movement development may be assessed. Appraisal in this study includes:

(a) judging the success of a subject in specific movement tasks

(b) recording the elements involved in the movement when the subject attempts the task and reviewing the record for the absence or presence of selected movement characteristics

(c) evaluating these findings in terms of movement pattern and results achieved

[5]Hicks, J. Allan. The Acquisition of Motor Skill in Growing Children: Child Development. 1:90-105, 1930.

It was found that the subjects progressed with varying but definite steadiness in their ability to perform successfully 25 movement tasks. Each subject in the oldest group was successful in each task at 6 or before.

(a) Gains were made with each year of age in most motor task scores indicating increasing development in the manner of performing the task and in the use of the elements considered integral to the task. Certain variations in performance tended to persist with the individual; some elements were never well established, e.g., lowering the center of gravity over the bar in the high jump and thrusting the legs forward in the standing broad jump.

(b) Some of the selected movement characteristics were as evident at 2 as later; others first appeared at 3 or 4 but almost all showed further improvement and use in later years.

Mature pattern, defined separately for each of the 25 tasks, was indicated by a score of 3 or better. This score was reached in most tasks by both boys and girls at age 5 but it was not reached at any age studied in catching and hitting. Since these tasks involve seeing, judging, and acting, they necessitate a variety of integrated responses for which the child may not yet be ready and for which he may need more preparation and experience than is usually attained by age 6.

7. Norms can be established for movement development. As assessed in this study movement development may be described for each age level yet it must be remembered that the performer and performance described is always hypothetical. The performance represents in most instances the mean performance of all the subjects at that age and it is probable that no child in the group conforms to the description. Thus the performer assumed for the performance and herein described does not exist. The described performance for each age does represent a norm for the subjects of that age enrolled in this study and so used may offer a criterion

of value for all persons concerned with young children.

The descriptions of achievement and development in movement have been summarized previously on pp. 12-24 for ages 2, 3, 4, 5 and 6.

8. Seven of the 8 movement characteristics selected for special study appear to be useful either singly or in combination as predictors of motor performance or as indicators of movement development.

Correlation of selected movement characteristics with motor score revealed high positive relationships with one or more balance activities at each age, and also with one or more aspects of total body assembly and opposition and symmetry at each age.

Motor score gave a high positive r with rhythmic locomotion from 2-5 and with eye-hand efficiency from 3-5 years. High r's were found with agility at 5 and 6 and for postural adjustment at 2 and 6.

Like-dominance was not significantly related to motor score at any age. This characteristic, usually right like-dominance, was so common in this study as to yield little variant information. A more varied and complete investigation has been started.[6]

All selected characteristics tended to correlate positively with motor score for all ages but negative correlation did occur. Positive correlations were more frequently high for age 3, 4, and 5 than for ages 2 and 6.

In statistical analysis it was found that the presence of a combination of these 7 characteristics or their components might be used as a predictor of motor score or as a criterior of movement development.

Single variables with significance in such prediction at .05 level of confidence were found for all ages. These vary from age to age as might be expected and include dynamic balance, total body assembly, rhythmic locomotion, opposition and symmetry, eye-hand efficiency, and, but with less frequency, agility and postural adjustment.

[6]Sinclair, Caroline B. Ear Dominance in Preschool Children, Perceptual and Motor Skills. 26:510 . 1968.

9. Basic movement patterns are established in early childhood. Movement patterns were easily identified by the similarities with which children executed the movement tasks and by the preponderance of likenesses in performance over differences especially among subjects of similar age.

These patterns may be divided into three classes:

(a) Those complete or almost complete at 2: carrying and creeping.

Since a child usually practices creeping or related activities from about 9 months to walking age it is understandable that he might be proficient at 3 but just why or how he is able to mobilize his energies so efficiently for carrying is not immediately evident. Perhaps since he has so recently freed his upper limbs from support and locomotion he is highly motivated for this task; certainly the zeal and persistence demonstrated by the 2-year-old in this task (and also in pushing and pulling) contributed to his early success.

(b) Those which were incomplete but not totally absent at 2 and which continued to develop after 2: ascending stairs, bouncing on a board, catching, climbing, descending stairs, forward roll, galloping, throwing, hitting, kicking, pulling, pushing, running, walking, and walking a beam. By six most children will have attained mature patterns in the performance of these motor tasks, though there will be later gains in achievement due to growth in size, strength and endurance and also increased skill if the child continues to practice and especially if he has well directed guidance and instruction.

(c) Those which emerged either in whole or in part after two: bouncing a ball (in part), figure-8-run(in part), hopping (in whole or almost), running high jump (in part), skipping (in toto), sliding (in toto), standing broad jump.

With the exceptions of bouncing a ball and throwing these tasks include elements of balance and thus are related; the delay in appearance and the completeness with which the pattern emerges might well be dependent upon the motivation of visual, kinesthetic, and other sensory and motor mechanisms concerned with equilibrium.

Patterns which are not established at 6 include catching, the figure-8-run, the forward roll, hitting, and kicking.

Specifically, more experience and perhaps more maturation is needed in order to deal with an on-coming object of which speed, size, impact and rapidly changing distance must be judged and for which adjustments must be made for receiving and retaining or imparting its momentum (catching, hitting, kicking). Also experience is needed in receiving and interpreting instructions and in planning in proper sequence the movements to carry out the task (figure-8-run). For many subjects the forward roll appears complete in pattern except for retention of the tuck or pike which permits the child to come to his feet; this needed element might be achieved through well directed motivation or by direct instruction. Vast improvements in performance are possible in the addition of elements which do not appear to be a part of the innate pattern but which will contribute to greater distances, better timing, etc.

10. Conditions for the study varied.

Although efforts were made to keep environmental and working conditions stable some variations occurred. For example, the jungle gyms used as climbing equipment for 5 and 6-year-olds offered greater variability than the ladders used for younger children.

Differences in motivation also occurred; it was previously noted that ball-of-foot contact and other elements related to speed showed little change at 6 from 5½; observation indicated that less effort to run fast was exhibited by the subjects

at 6. The consistently low times recorded for running in Phase III which were less than those recorded for the same subjects at greater ages (Table VI) also suggest the possibility of consistent inaccuracy in timing in Phase III.

The variability of human subjects is well established and often unaccountable. Subjects with high motor scores showed less variability than subjects with low motor scores but some variability in cooperation, effort, and enjoyment occurred in nearly all subjects.

In photographing, lighting conditions an background control were far from ideal and varied with season, location, and the weather.

Chapter V

Conclusions and Recommendations

I. Conclusions

1. If motivations and opportunity are provided normal preschool children will perform a variety of movement tasks successfully and will use movement patterns which are similar and which emerge and/or develop according to a predictable time table.

2. Motor performance and movement development vary with age, sex and the individual studied.

3. Two criteria appear as effective for the evaluation of a young child's development: (1) his progress over a period of time and (2) his achievements and patterns as compared with those of other children his age.

4. Seven characteristics have been identified which appear to be significant in the movement development of young children. They are (1) dynamic balance (2) opposition and symmetry (3) total body assembly (4) rhythmic location (5) eye-hand efficiency (6) agility and (7) postural adjustment.

II. Recommendations

1. Studies should be made to develop curricula for preschool children which will focus upon and aid in the development of good movement.

2. Similarly curricula should be developed for the more adequate preparation of early childhood teachers in the area of movement development.

3. Studies should be developed to devise and test methods to be used in working with young children to help them develop good movement and derive the benefits which accrue from it.

4. Movement as a factor in learning and in the development of readiness to learn needs further exploration; it is especially recommended that the exploration focus on gross movement in early childhood.

5. Since 4, 5 and 6-year-old children manifest sex differences in movement which persist and since they also show differences in other areas of development, these should be further investigated in order to devise early education programs which are best suited to the development of each sex.

6. Physical educators should extend their perspectives and their studies to provide for preschool children. It is at this early age that the most significant achievements may be made.

7. Parents are in need of information about the movement of young children. A multi-disciplinary approach in schools, colleges and adult education is recommended.

8. This study yields meager information on dominance variation. The data do suggest the association of movement and learning problems with variant dominance patterns. Investigation in the preschool years with continuation and/or follow up in the primary grades should include eye and ear preferences as well as those for hand and foot.

9. This study is limited in number of subjects, geographical area, and study conditions. It is recommended that the normative descriptions given for each age be studied. Other studies should be made using larger groups in other locations and under other conditions.

10. The normative movement patterns presented in this report should be subjected to further examination through studies by other researchers.

11. Other studies should be made in order to find or verify a motor task or combination of motor tasks to be used as a reliable and valid test of motor development in early childhood.

12. Studies should be made of young children in which other factors such as race, home conditions, etc., may be evaluated as affectors of movement development.

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Appendix I

List of Equipment

This list does not include fixed equipment such as stairways, jungle gyms, etc.

balls — 1 rubber playground ball (volley ball size) used for all "large ball" tasks

3 tennis balls used for all "small ball" tasks

ladders — 1 step ladder, 5'6" high used for Phases II & III and for subjects of ages 2-5

1 step ladder, 5'6" high used for Phases V & VI and for subjects of ages 3-5

(Fixed apparatus was used for Phases I & II and for all 6's and for some 5's)

1 blanket — used folded for creeping and to supplement foam rubber sheet as mat, also as station for waiting, talking and playing

1 foam rubber sheet 64" x 81"
used for creeping and when folded as a mat for jumps and forward roll

1 adjustable batting tee consisting of:
a wooden block 4" x 4" x 18" with a round hole for the lead pipe

a 12" length of lead pipe, 3/4" diameter

an 11" length of plastic hose 5/8" diameter with a 1-1/8" receptacle on one end

The hose must fit the pipe snugly but can be moved up or down to adjust height.

small bats — 1 of wood, 18" in length

1 of plastic, 29" in length

A choice of these was allowed.

cloth bags, strongly made and with carrying handles

1 - 12" x 12" x 2" used for 3-year-olds in Phases V and VI

1 - 16" x 16" x 2" used for 4, 5, and 6-year-olds in Phases V and VI

Previously a similar bag was used for all ages.

plywood — 1 piece, 1/8" plywood, 18" x 6" used as a take off mark for the standing broad jump for ages 3-6.

jump standards, 1 pair standards with pegs used for the running broad jump

bounce board — consisting of: 1 piece of ½" marine plywood 4' x 8' with cleats 3'6" in length to fit over the sawbucks

sawbucks — 2 miniature sawbucks 12" in height and 6" in spread, 3'6" long. (wood dressed and waterproofed)

stop watch — used for timing runs

drum — used to motivate galloping, sliding, and skipping in introduction (records were also used for this but the drum proved the more satisfactory)

4 markers — consisting of wooden blocks dressed and waterproofed used to mark distances and stations and to define the course for the figure-8-run; and also to weight the blanket and foam rubber sheet on windy days; these markers were supplemented when necessary with the walking beam blocks and the closed measuring tape.

4 weights — consisting of:

2 8 lb. bricks wrapped in cloth and supplied with carrying handles

1 4 lb. weight

1 2 lb. weight

used in the following combinations for carrying:

1 8 lb. weight for 2-year-olds = 8 lb.

1 8 lb. weight + 1 2 lb. weight for 3-year-olds = 10 lb.

1 8 lb. weight + 1 4 lb. weight for 4-year-olds = 12 lb.

2 8 lb. weights for 5-year-olds = 16 lb.

2 8 lb. weights + 1 4 lb. weight for 6-year-olds = 20 lb.

3 small chairs (seat 11-12 inches from floor)
used (1) for the standing broad jump for two-year-olds

used as a seat for the helper for creeping (playing the game Kitty Kitty)

used as waiting stations for children

used as waiting station for investigator

walking beam	consisting of: 1 - 2" x 4" x 8' 2 blocks constructed as receptacles for the ends of the 2" x 4" and to fit either the 2" or 4" width (wood was dressed and weatherproofed)
wood bench	constructed with a top measuring 11" x 32", a height of 16½", and nylon pads for easy sliding (wood was dressed and weatherproofed) used for pushing and pulling and "ridden" astride by a child of the same approximate size and weight as the subject
50' steel tape	used for measuring distances, as a guide in throwing (when stretched for direction) and as a marker for various tasks (This was an attractive item to the children because of its red case and because they liked to wind it up and help to use it for measuring)

Reading Test													
Subject 019	✓	✓	✓	✓	✓	A	✓	✓	L	✓		4	
018	✓	✓	✓	✓	✓	✓	✓	✓	R	✓		4	
017	✓	✓	✓	✓	✓	✓	✓	✓	R	✓		5	
016	✓	✓	✓	✓	✓	✓	✓	✓	R	✓		5	
015	W												
014	✓	✓	✓	✓	✓	✓	✓	✓	L	✓		5	
013	✓	✓	✓	✓	✓	X	✓	X	R	X		3	
012	✓	✓	✓	✓	✓	✓	✓	✓	L	✓		5	
011	✓	✓	✓	✓	✓	X	✓	✓	L	✓		4	
010	✓	✓	✓	✓	✓	✓	✓	✓	L	✓		5	
009	✓	✓	✓	✓	X	X	✓	✓	L	X		3	
008	✓	✓	A	✓	✓	X	✓	✓	—	✓		3	
007	✓	✓	✓	✓	✓	✓	✓	✓	R	X		4	
006	✓	✓	✓	✓	✓	✓	✓	✓	R	X		4	
005	✓	✓	✓	✓	✓	✓	✓	✓	L	✓		5	
004	✓	✓	✓	✓	✓	✓	✓	✓	R	X		4	
003	✓	✓	✓	✓	✓	✓	✓	✓	L	✓		5	
002	✓	✓	✓	✓	✓	X	✓	✓	—	✓		4	
001	✓	✓	✓	✓	✓	✓	✓	✓	R	✓		5	

1951-65 Pine Tree Study Type 2s Allegany

A 1951 C56	X	X	X	X	X	X	X						C
C55	X	cc	[illegible]										C
C54	✓	L	✓	X	X	✓	✓						2
C53	X	C	[illegible]										C
C52	X	[illegible]											C
C51	X	[illegible]											C
C50	✓	L	✓	X	✓	C	✓						2
C49	X		[illegible]										C
C48	X		[illegible]										C
C47	✓	L	✓	X	X	✓	X						2
C46	X	X	X	X	X	X	X						C
C45	✓	R	✓	X	✓	✓	✓						2
C44	✓	L	✓	X	✓	✓	✓						2
C42	✓	R	✓	X	X	✓	✓						2

APPENDIX III

COMMONWEALTH OF VIRGINIA

MADISON COLLEGE
HARRISONBURG, VIRGINIA 22801

January 4, 1968

Dr. Caroline Sinclair
Research Services
Richmond Public Schools
Richmond, Virginia

Dear Dr. Sinclair:

Thank you very much for the opportunity to review your analysis and those of the three reviewers and also the comments by the reviewers. We have been over the material and, in our opinion, a statistical analysis with such a small number would not warrant the time and effort. It is evident that there is marked agreement among the responses of the reviewers and of those with yours.

A careful comparison of the reviewers' comments indicate that your check forms are very effective in rating movement patterns. The comments of the reviewers support the validity of your instrument.

Thank you for sharing your first year's observations with us!

Sincerely yours,

L. Leotus Morrison, Professor

Patricia J. Bruce, Professor
Physical and Health Education

LLM:bjb

APPENDIX III

PURDUE UNIVERSITY
SCHOOL OF HUMANITIES, SOCIAL SCIENCE AND EDUCATION
DEPARTMENT OF EDUCATION
LAFAYETTE, INDIANA 47907

DEPARTMENT OF EDUCATION
ACHIEVEMENT CENTER FOR CHILDREN

October 25, 1966

Miss Caroline Sinclair, Consultant
Research and Development
Richmond Public Schools
Administration Building
312 North Ninth Street
Richmond, Virginia 23219

Dear Miss Sinclair:

Thank you very much for your letter of October 14. We are very happy that you found the Movement Pattern Checklists useful in your study.

You have our consent to acknowledge these materials when your study is reported. We would appreciate very much receiving a copy of this study.

Cordially yours,

N. C. Kephart, Ph.D.
Executive Director
Achievement Center for Children

NCK:sjk

Appendix IV

Case Study No. 012

Birth: 6-14-62

Age for Phase I 4-4 Phases Studied I-V

Medical Findings L. eye unsat. (bleary) Date of Medical 2-1-67

Other health related data: Body alignment poor.

Psychological Test Non-verbal (Gesell Copy Forms) Ph. II. Teachers Estimate Ph. VI Poor +2

Date May 1967 Quotient IQ 112

Score MA = 5.50

Sex F Race White Other data: Father has no steady job; 7 children

Motor Score for each Phase:

I 45 II 52.0 III 57 IV 56.8 V 63 VI _____ Mn 54.8

Above or below mean for group +.5

I -7 II +.4 III +3.6 IV +1.9 V +2.1 VI _____

Group Mean Slightly above average and consistent after Phase I (seemed disturbed in this phase)

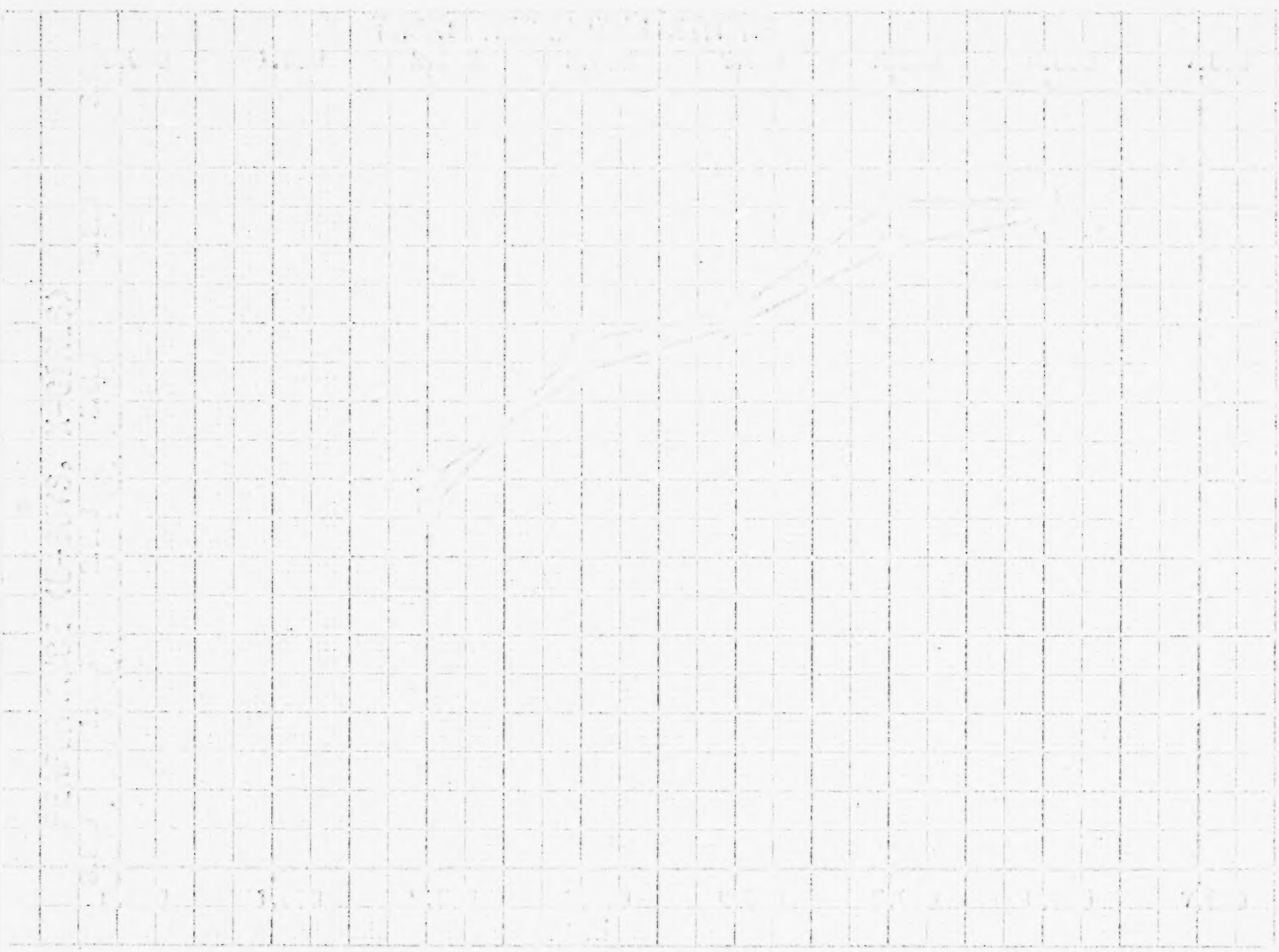
Comment re specific motor tasks:

Other comments: 3-18-69 Teacher reported slow but steady progress with reading limited and other achievements below grade level. In November the child seemed to be doing average work.

RR% October 1968 = 23

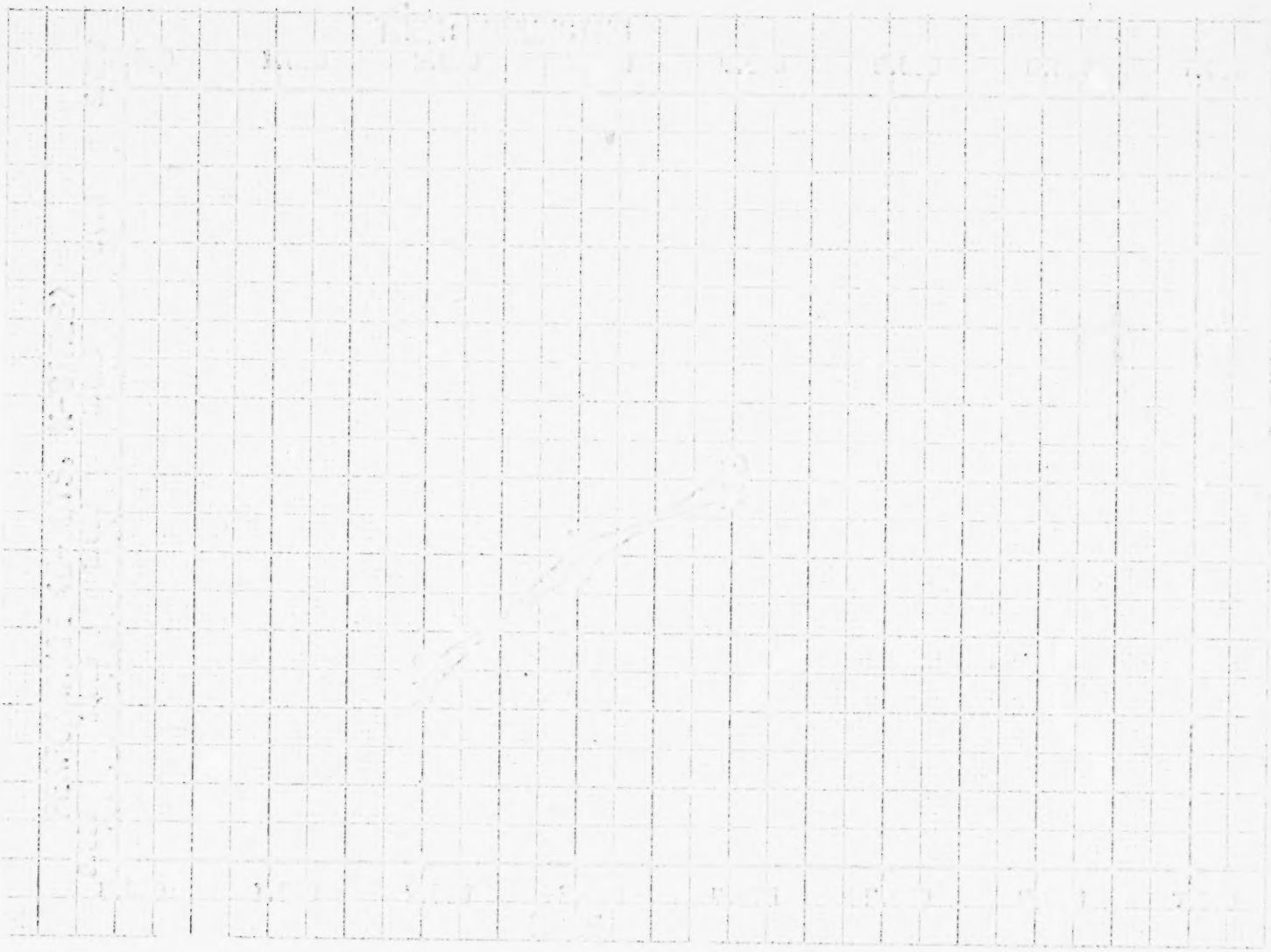
Recommendations or suggestions:

CHART 1



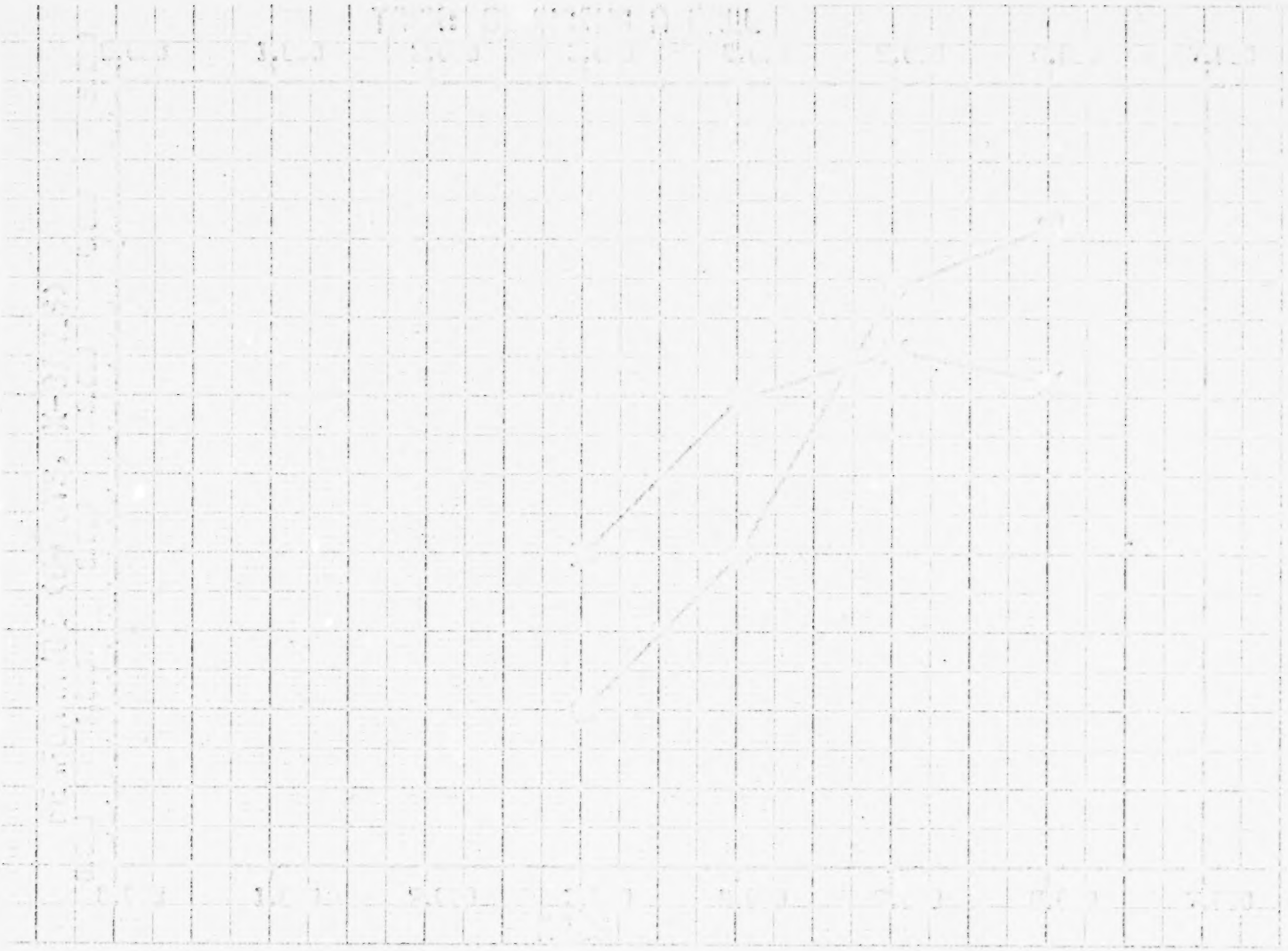
Ascending stairs

CHART 2



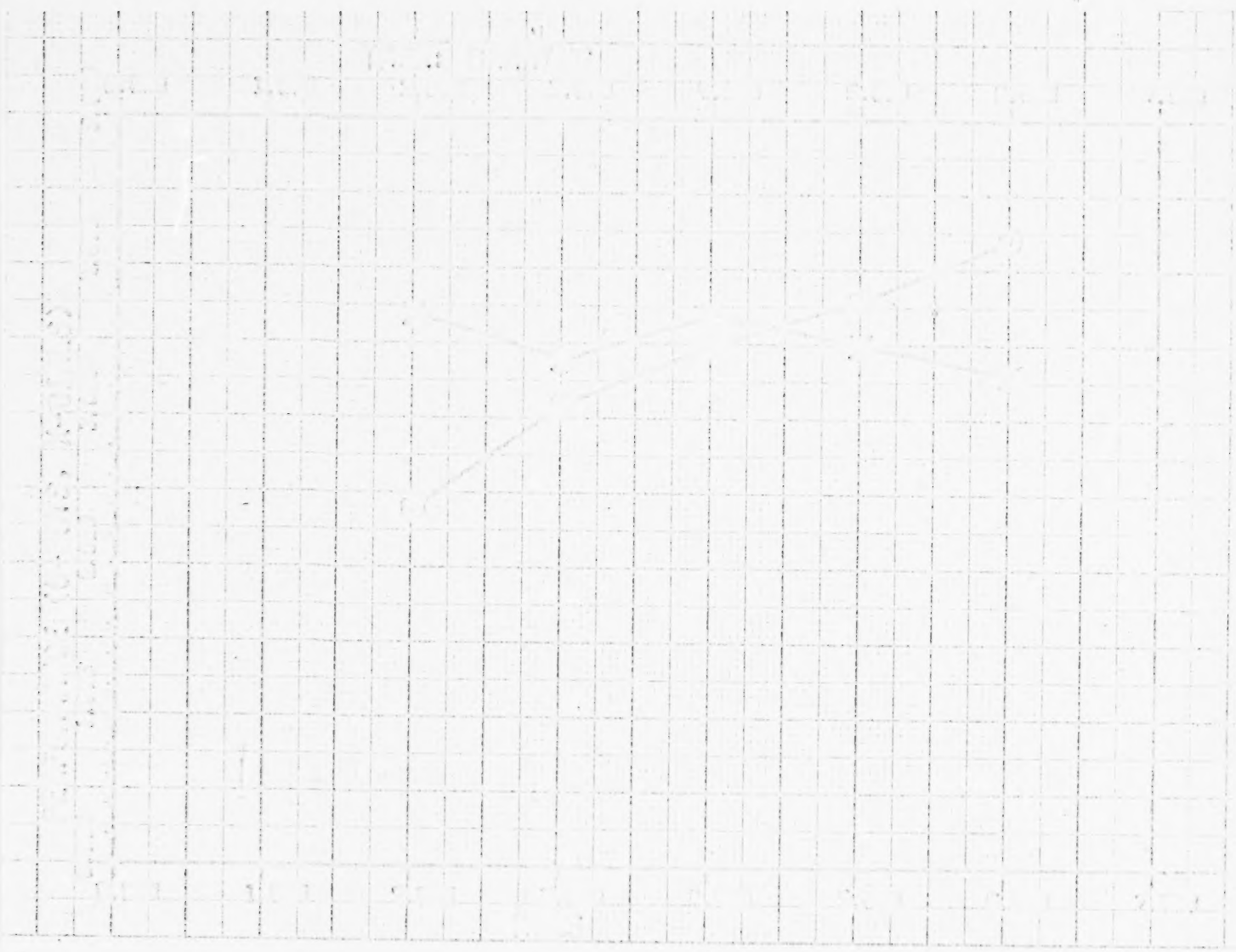
Bouncing

CHART 3



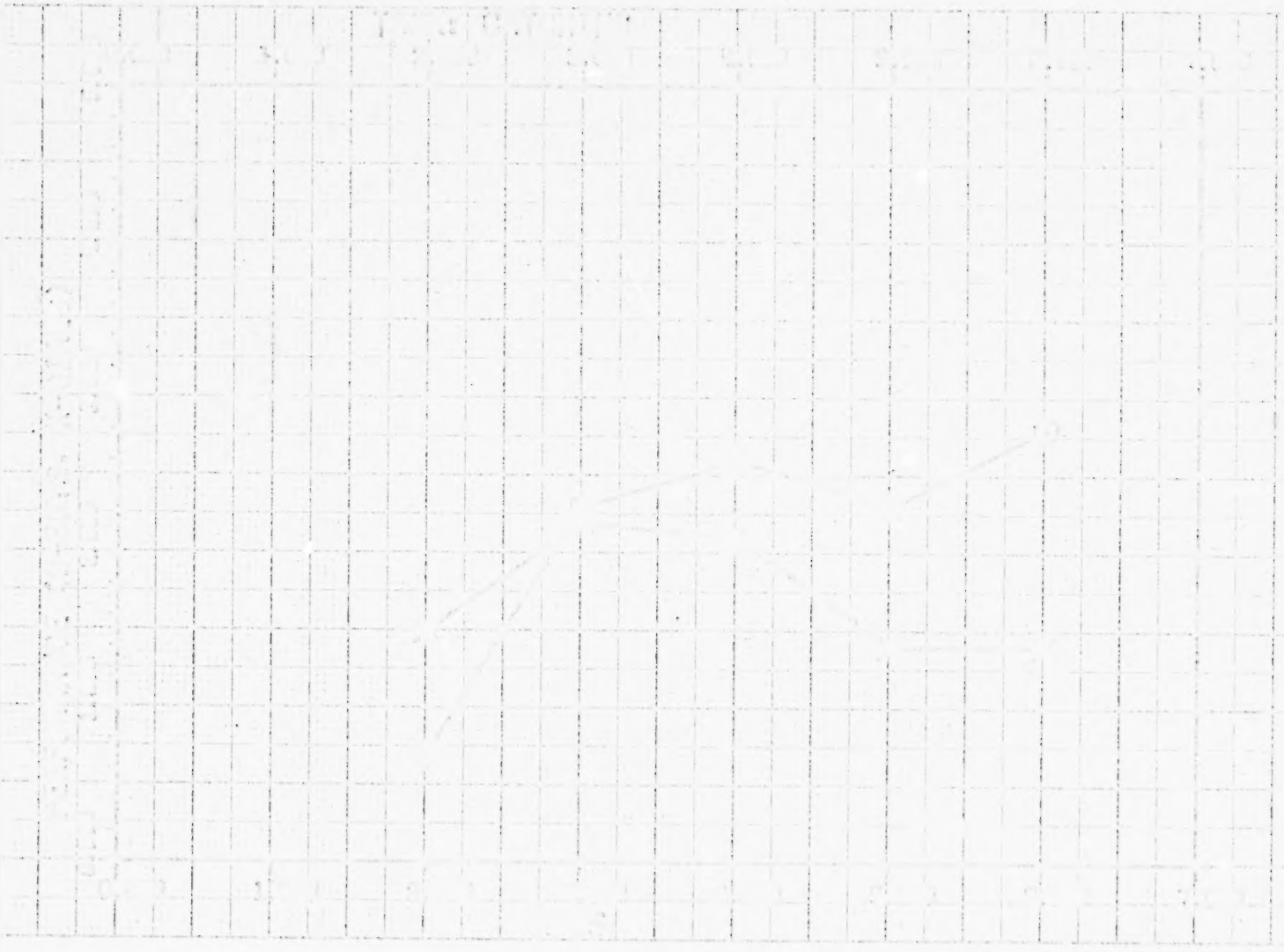
Bouncing a ball

CHART 4



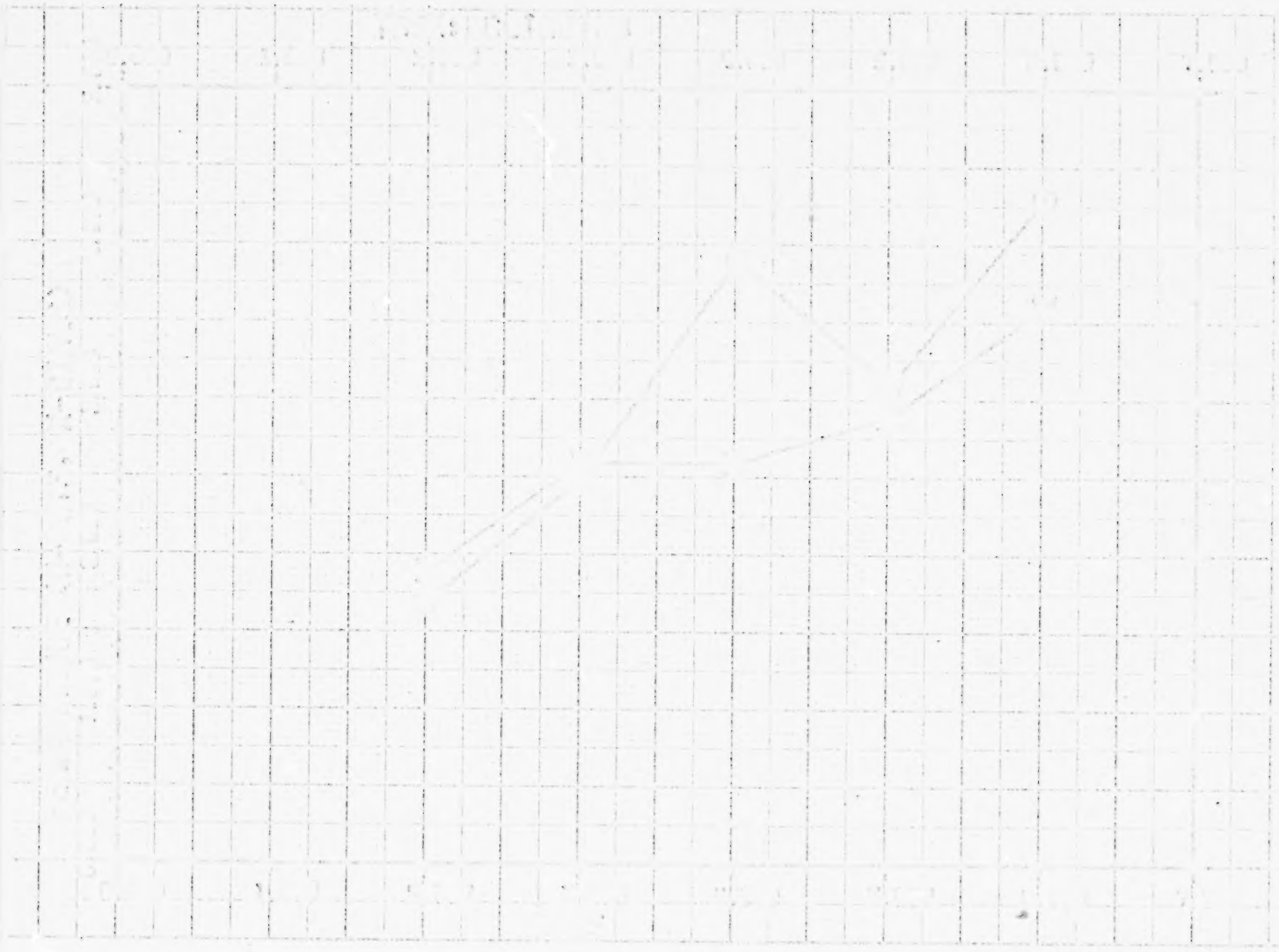
Carrying

CHART 5



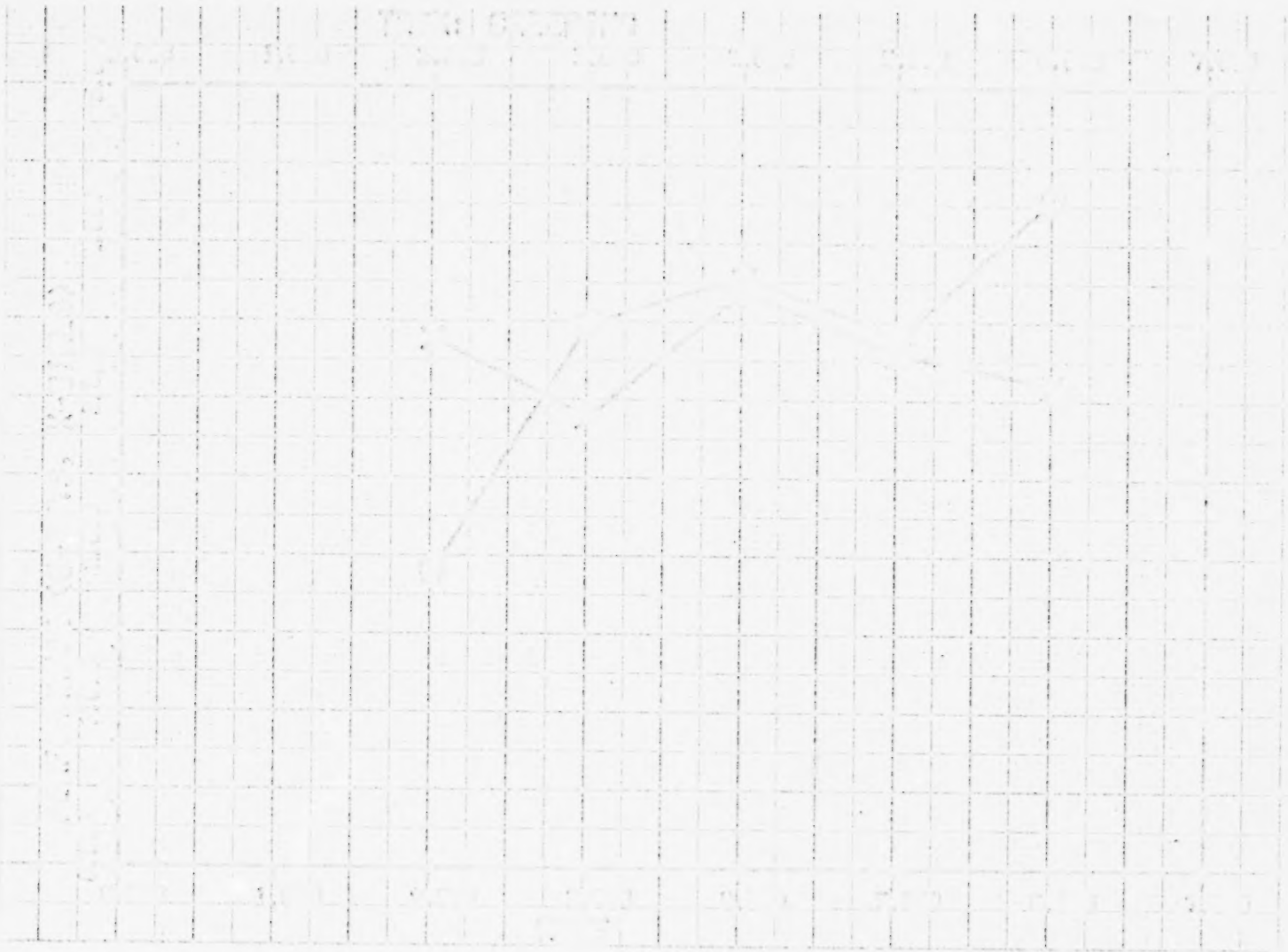
Catching

CHART 6



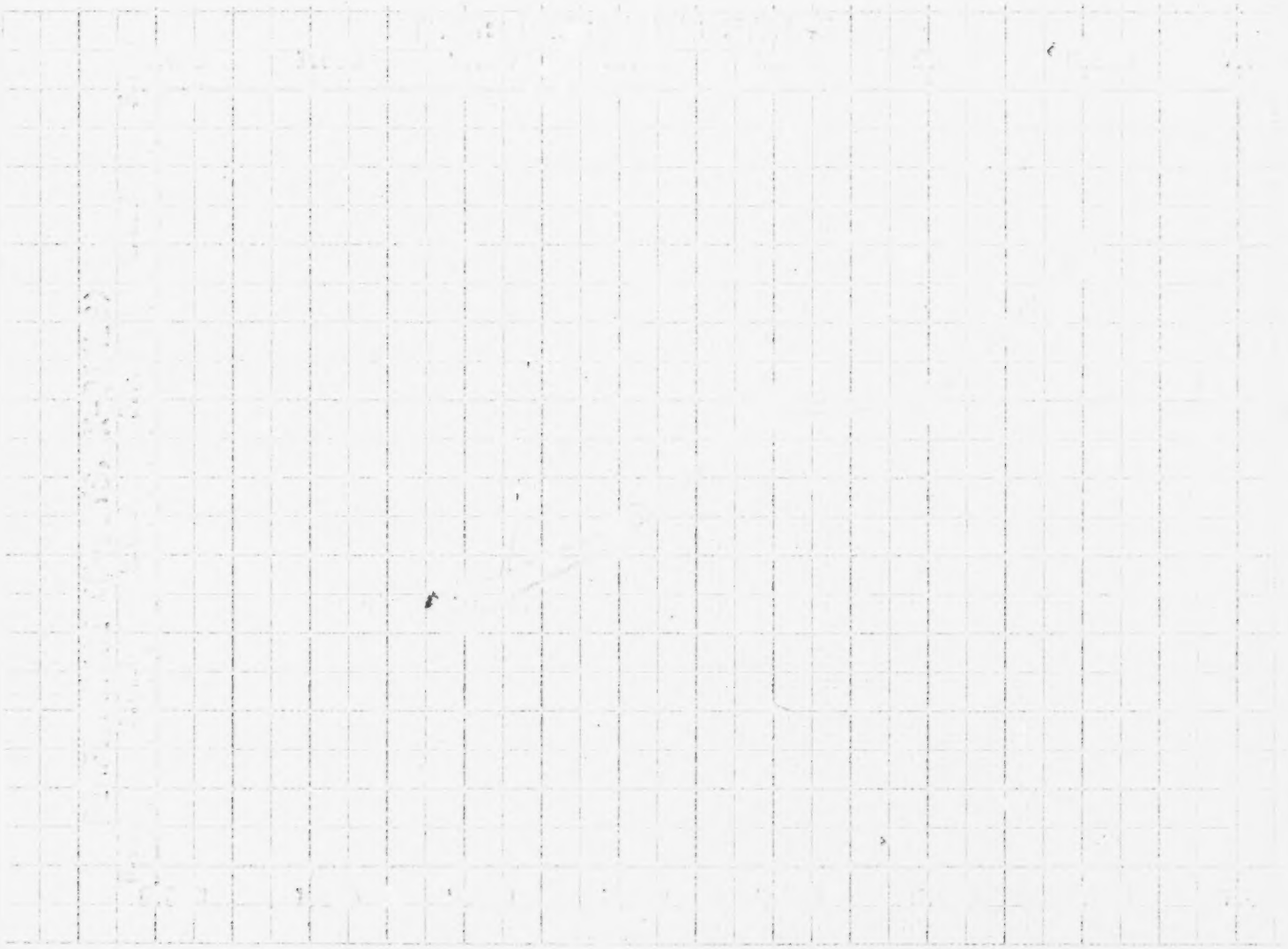
Climbing

CHART 7



Creeping

CHART 8



Descending stairs

CHART 9

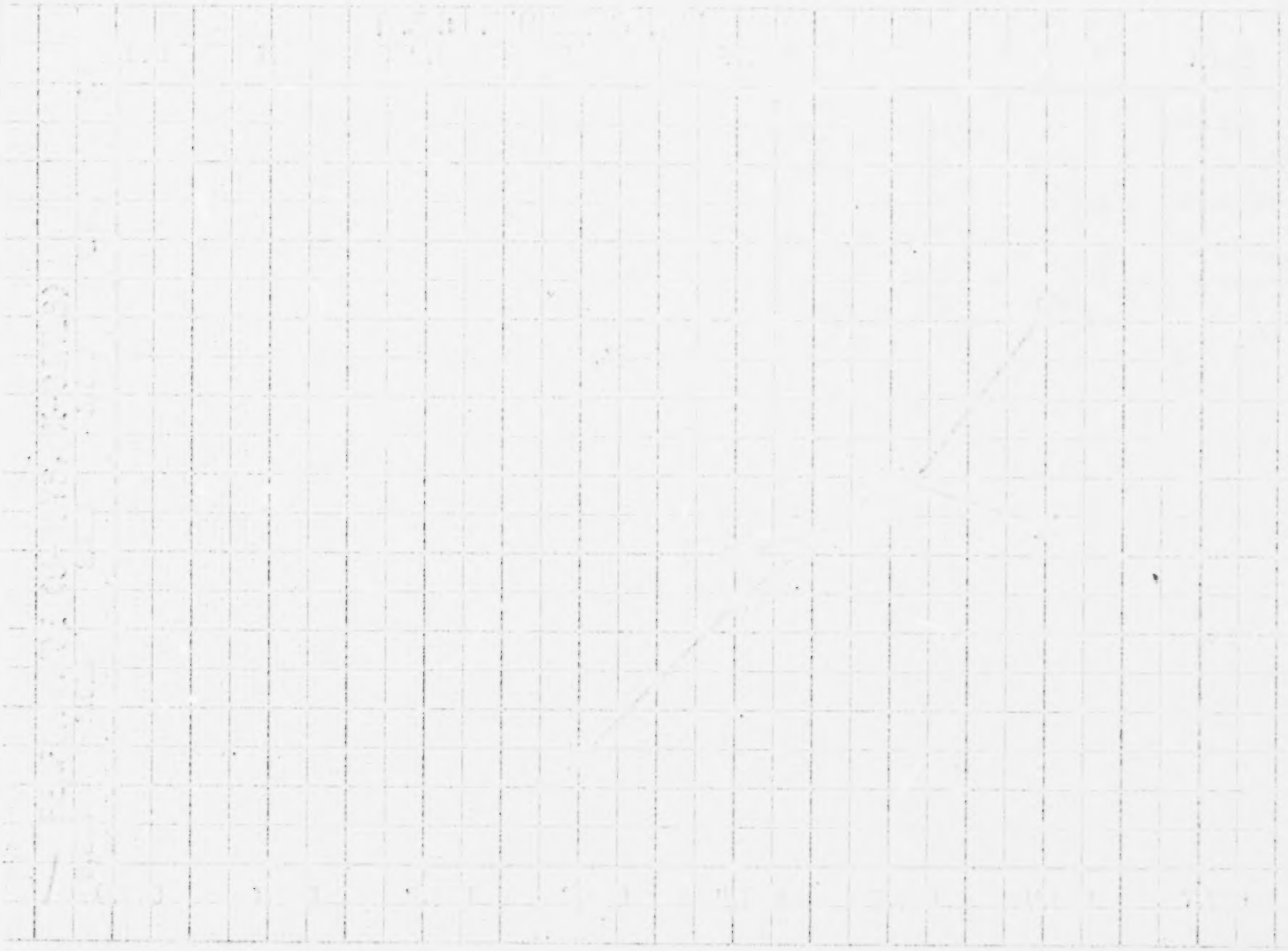
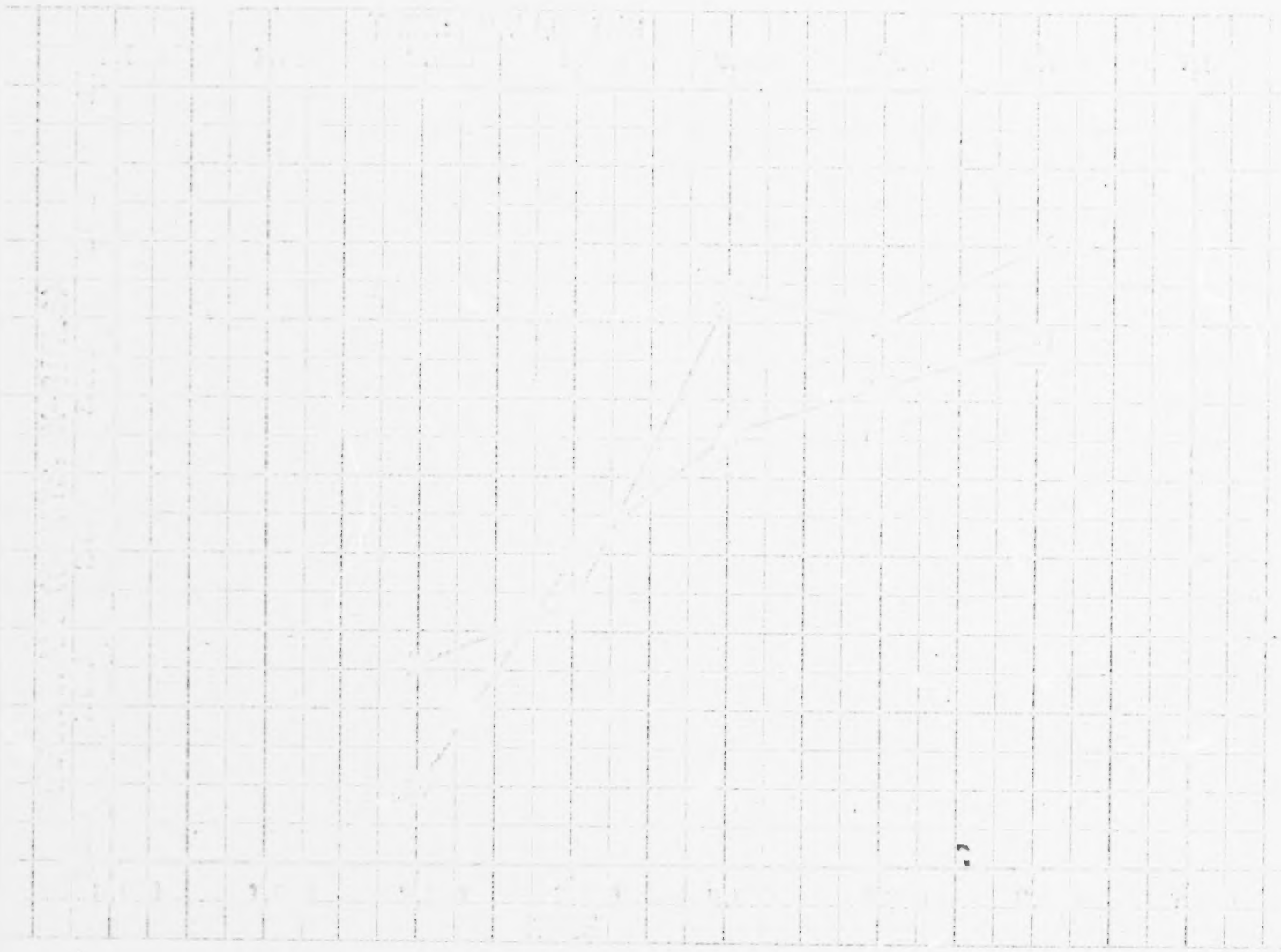


Figure--8- Run

CHART 10

Forward roll

CHART 11

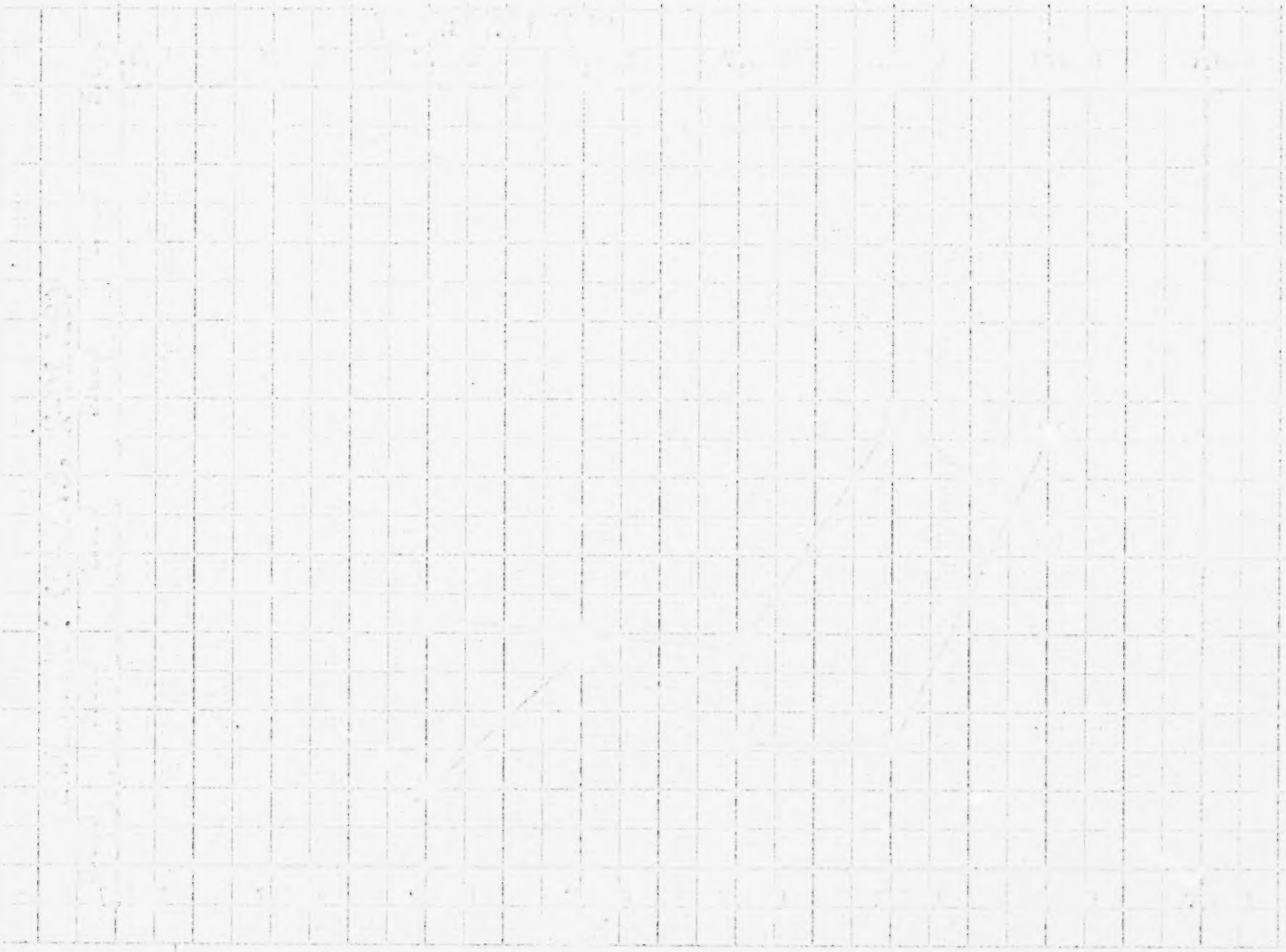


Galloping

CHART 12

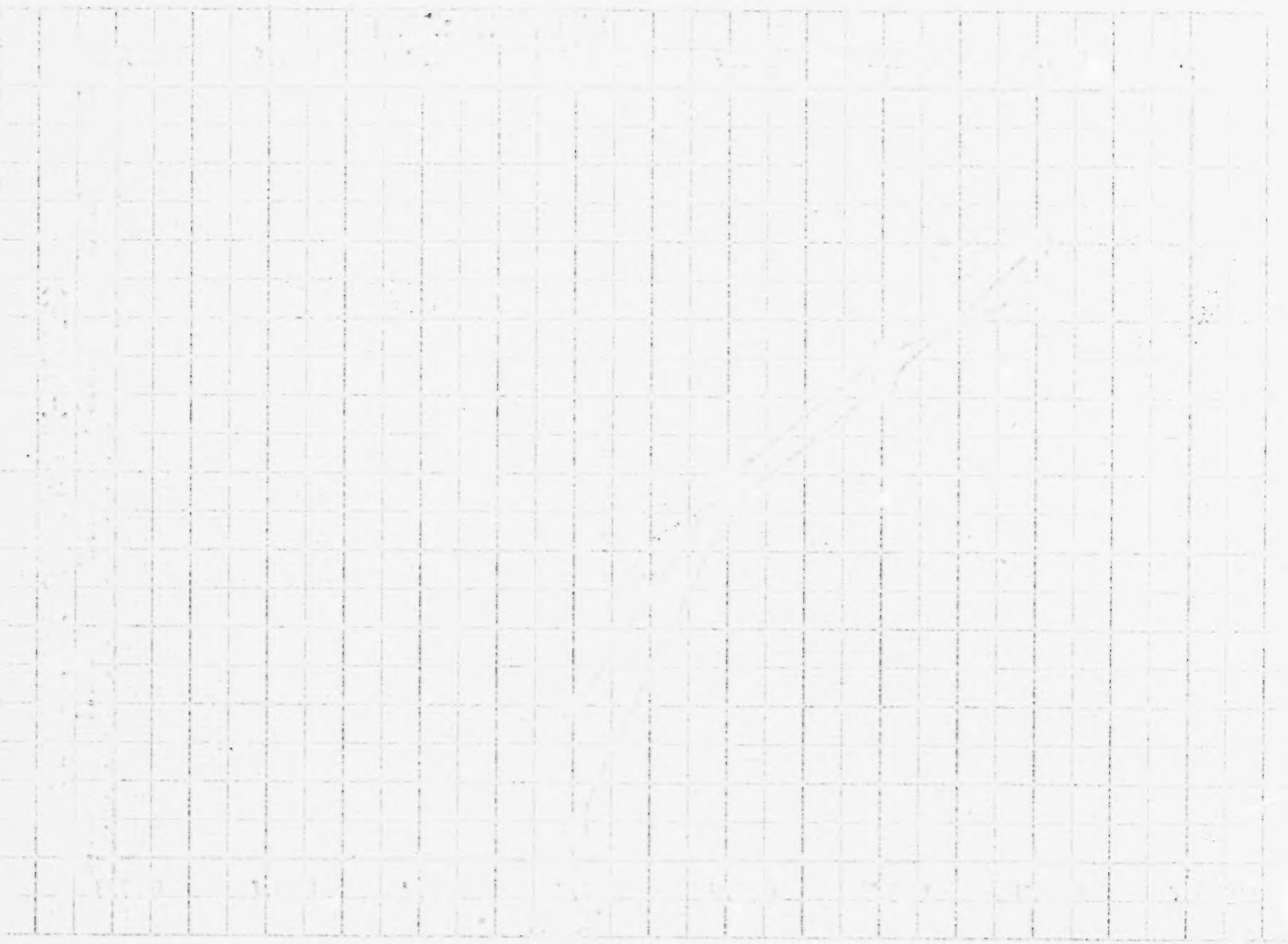
Hanging

CHART 13



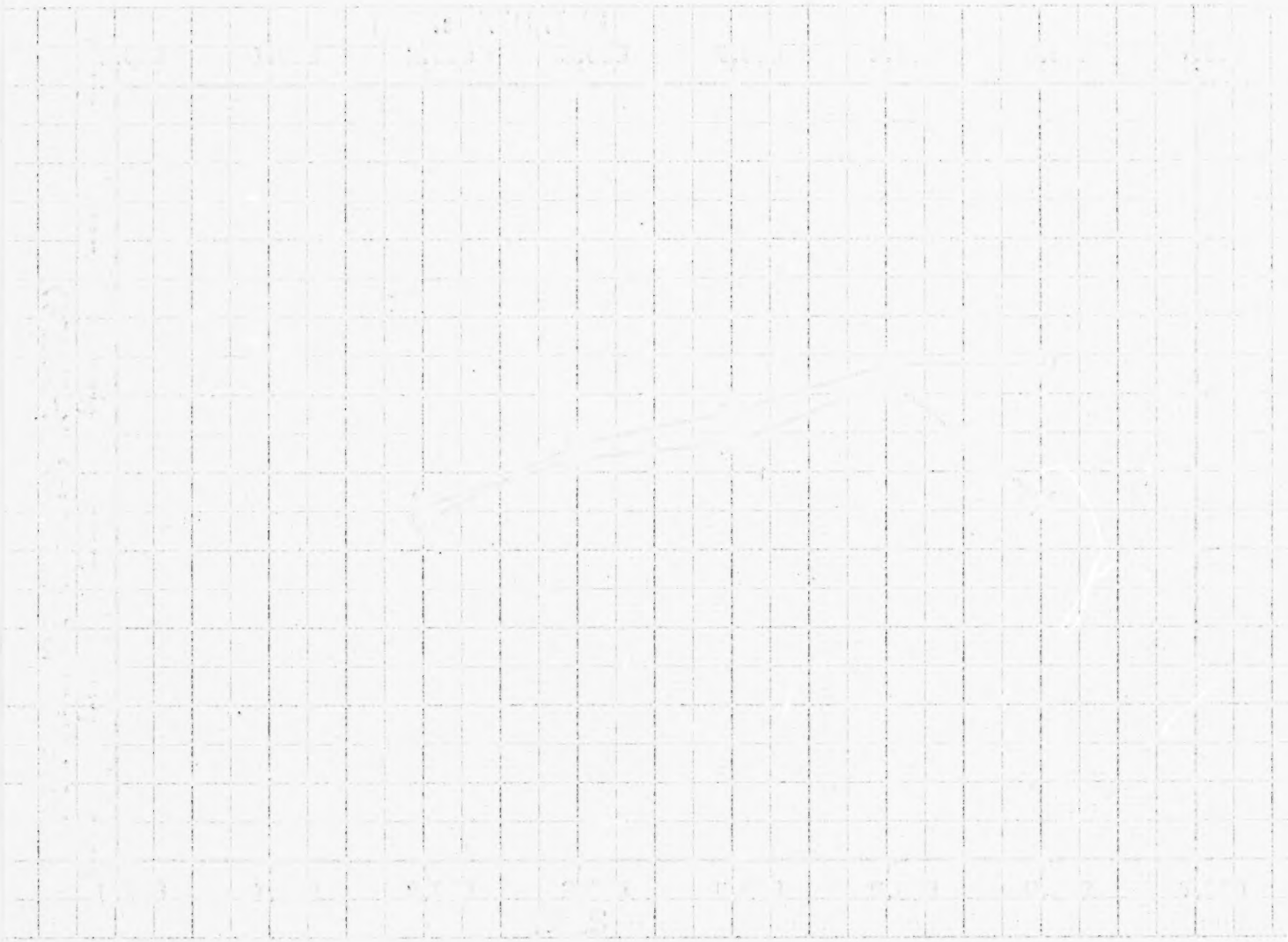
Hitting

CHART 14



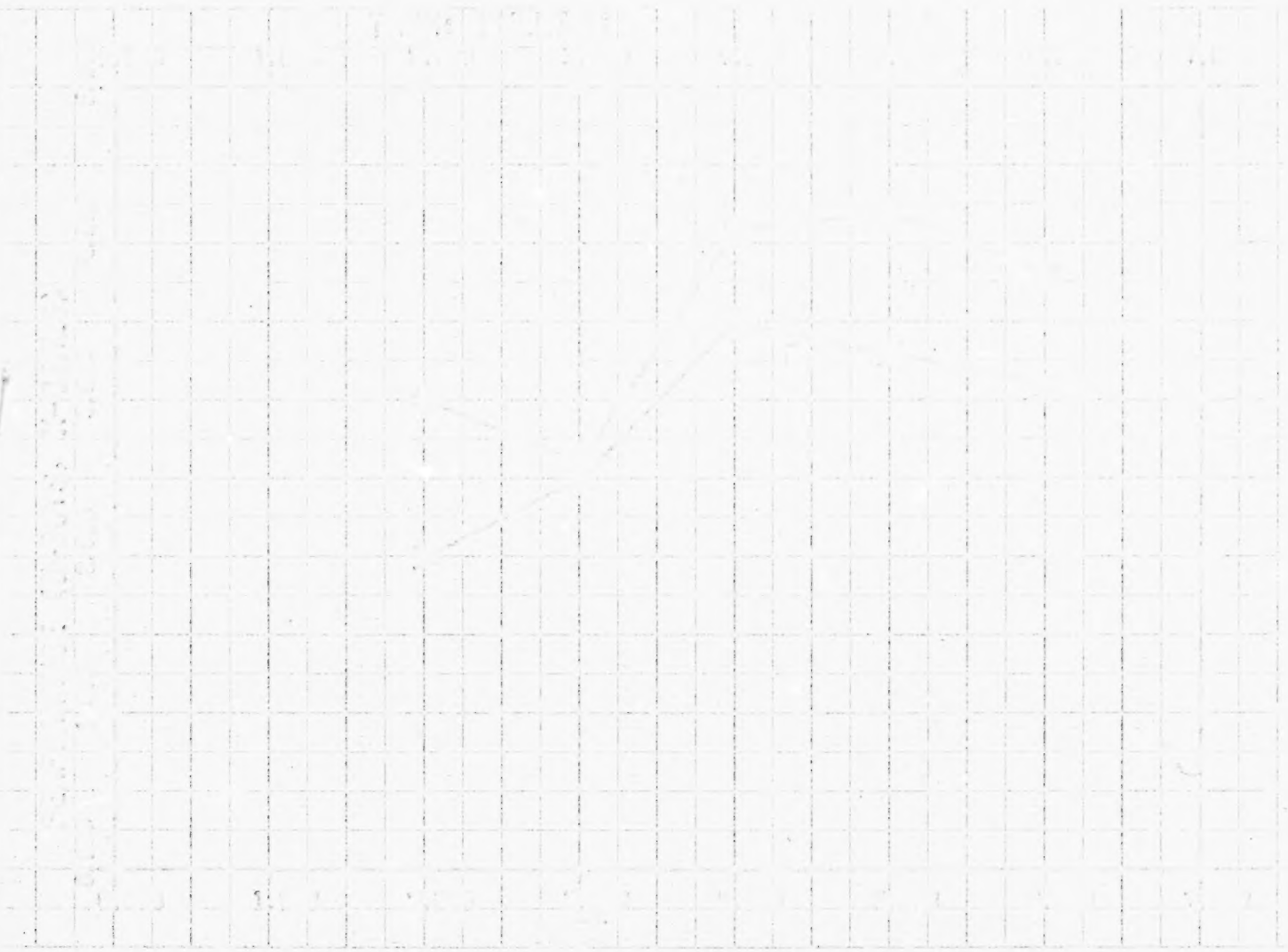
Hopping

CHART 15



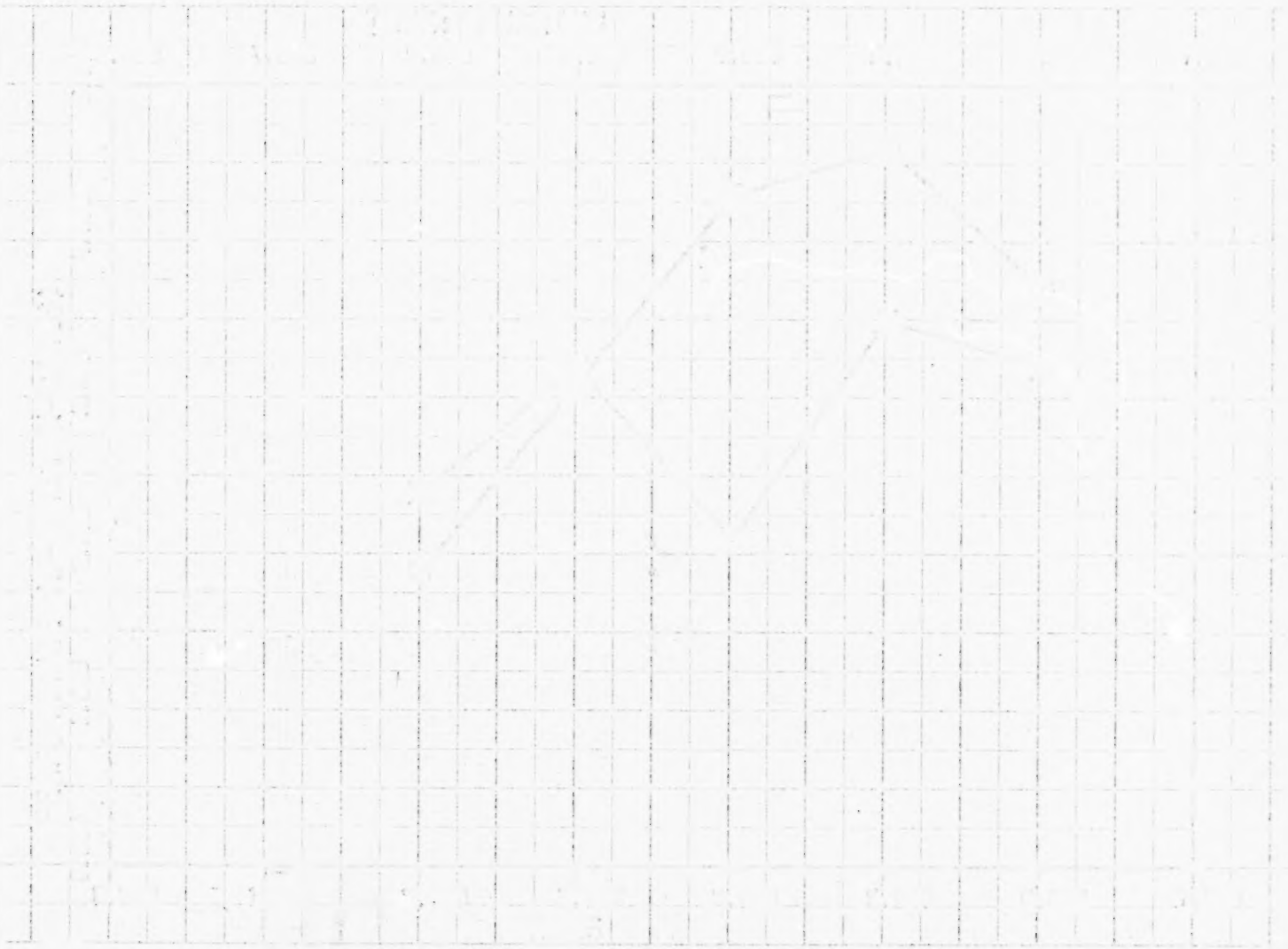
Kicking

CHART 16



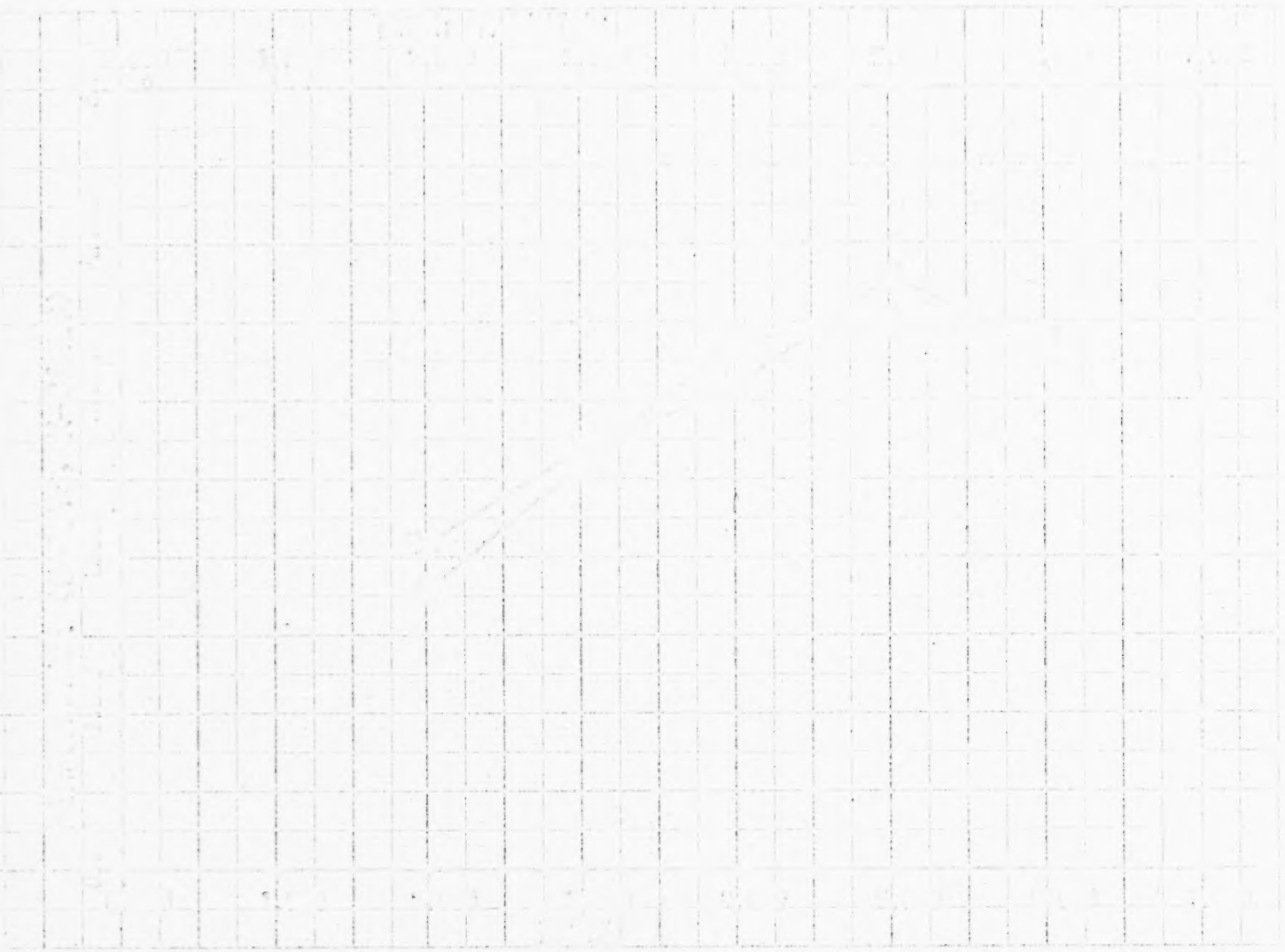
Pulling

CHART 17



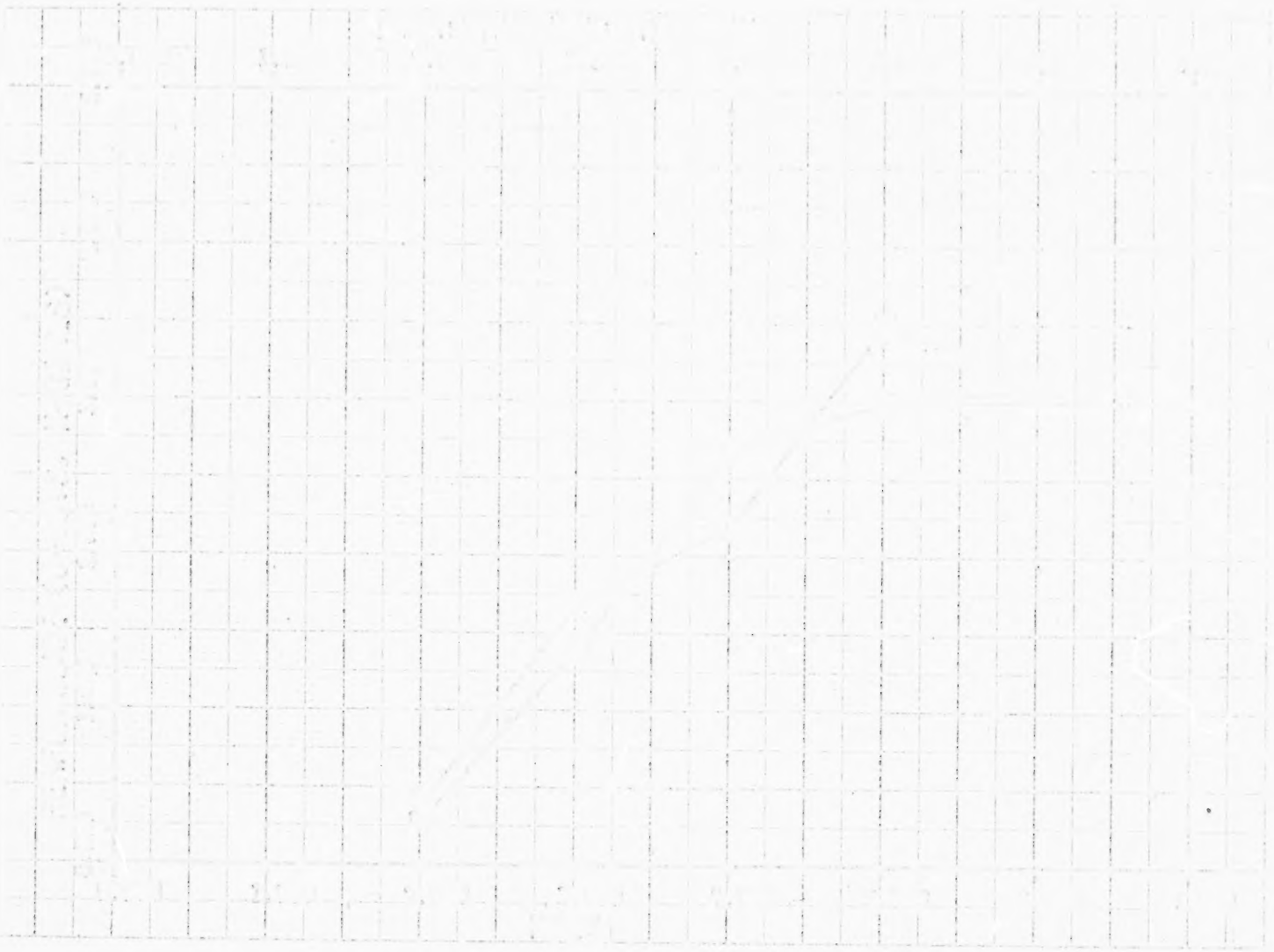
Pushing

CHART 18



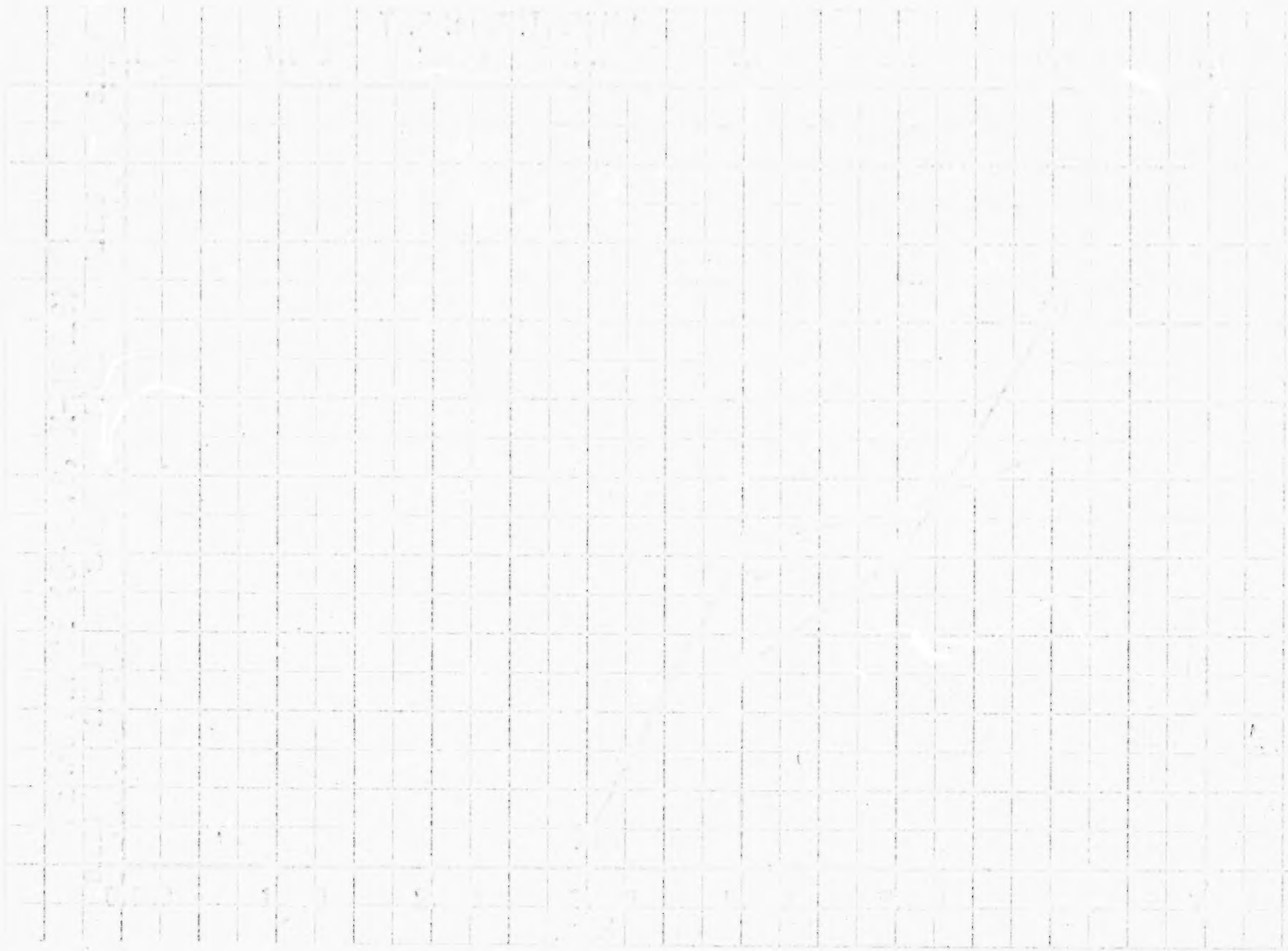
Running

CHART 19



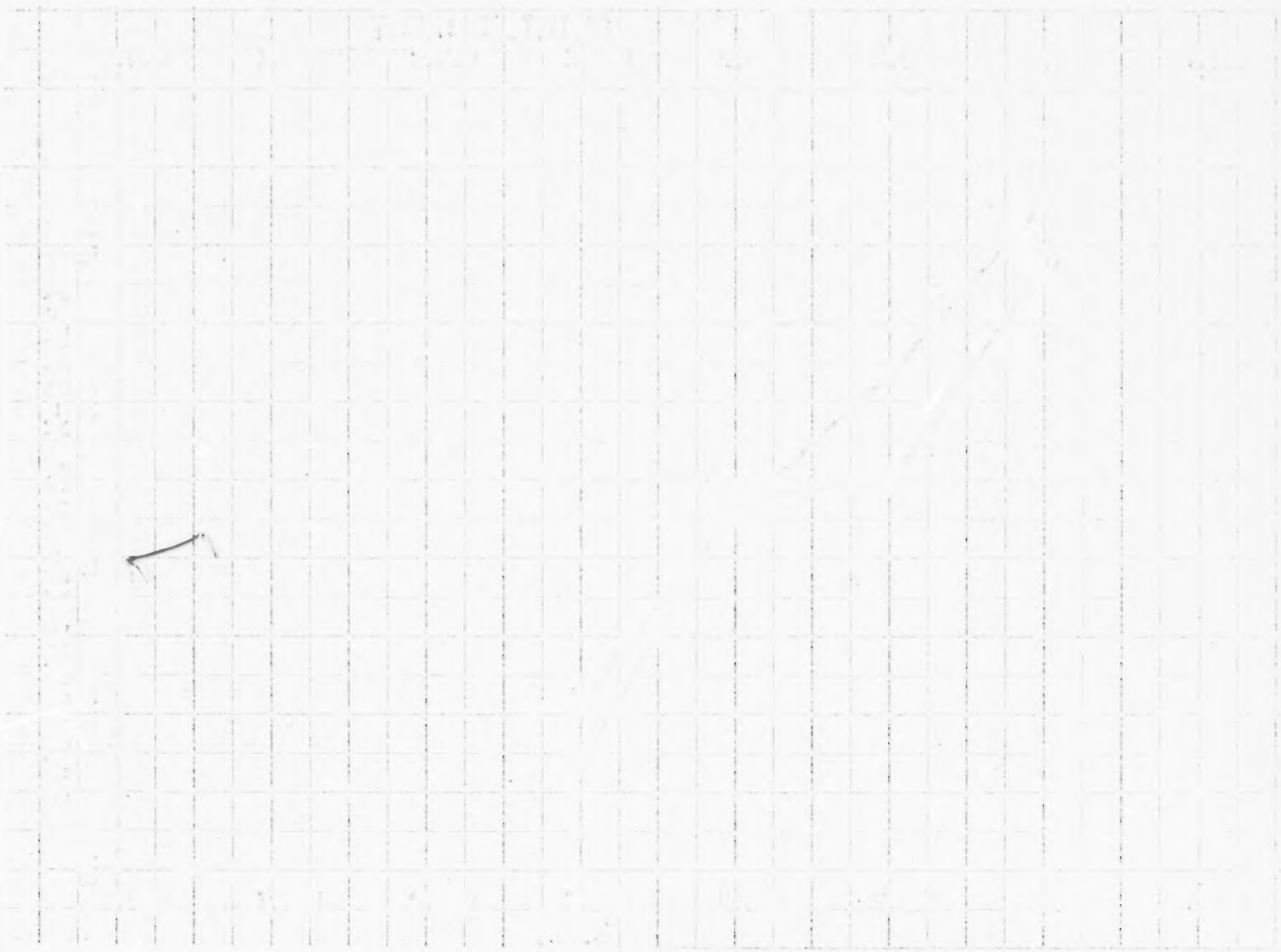
Running high jump

CHART 20



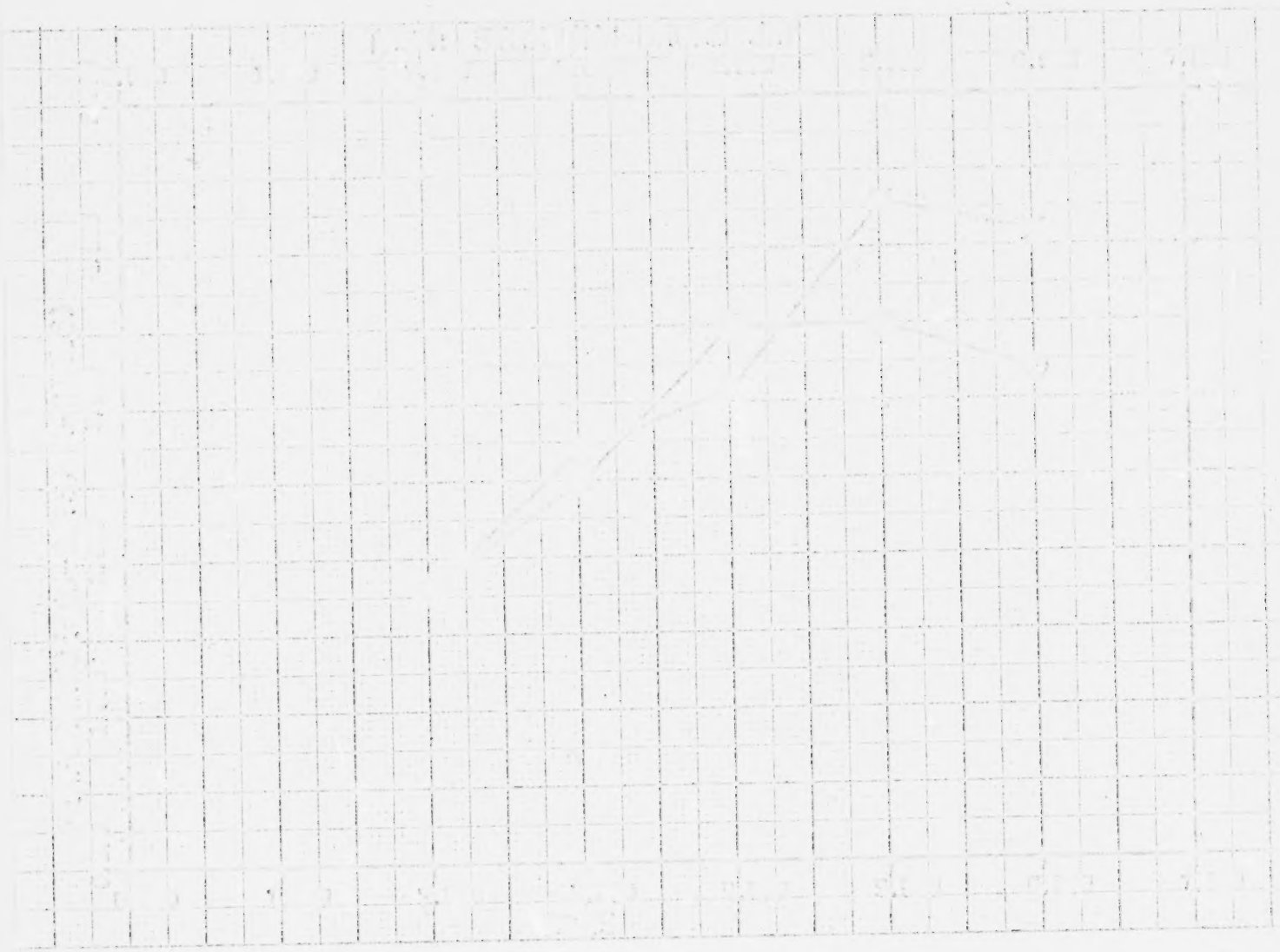
Skipping

CHART 21



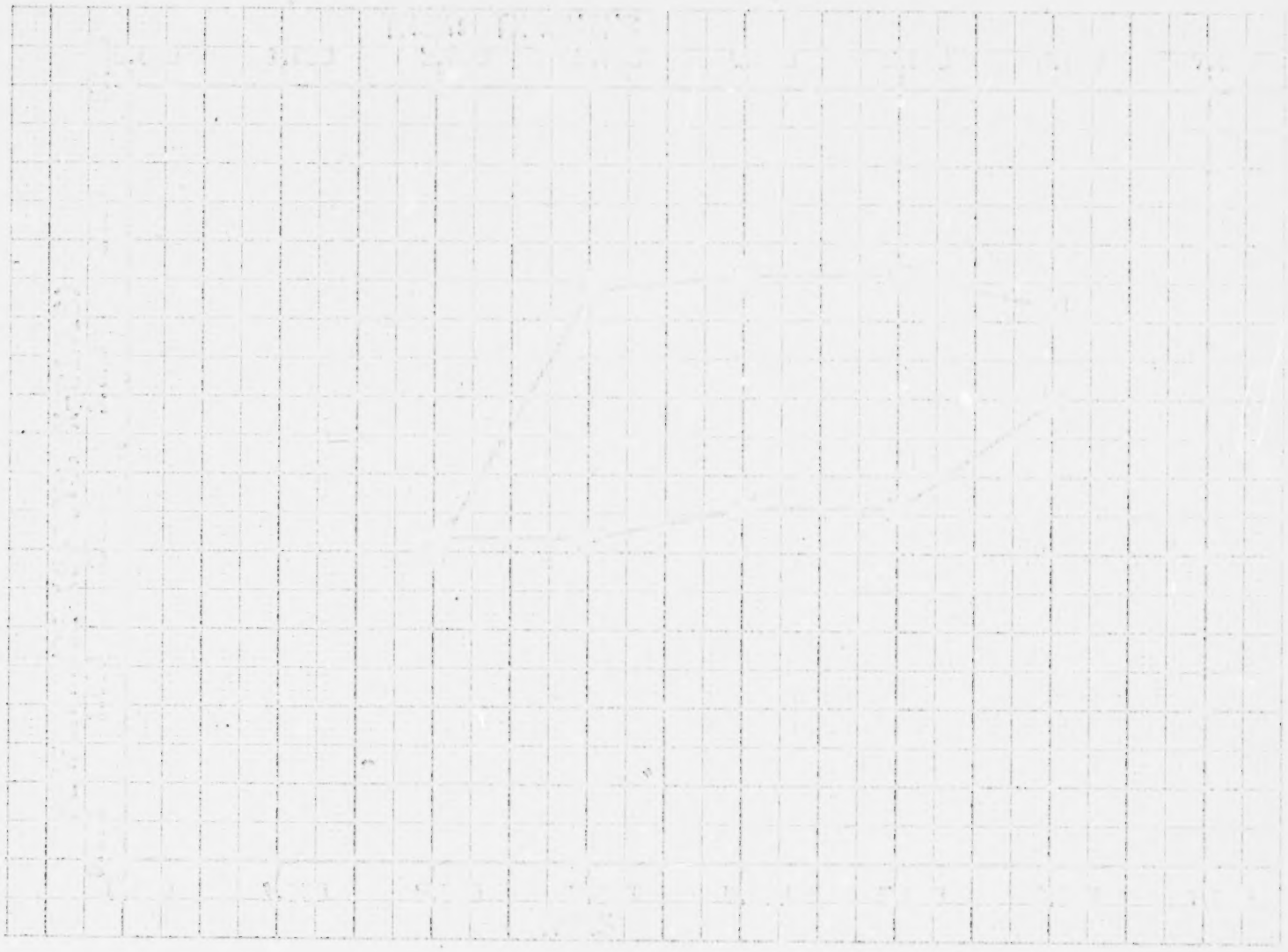
Sliding

CHART 22



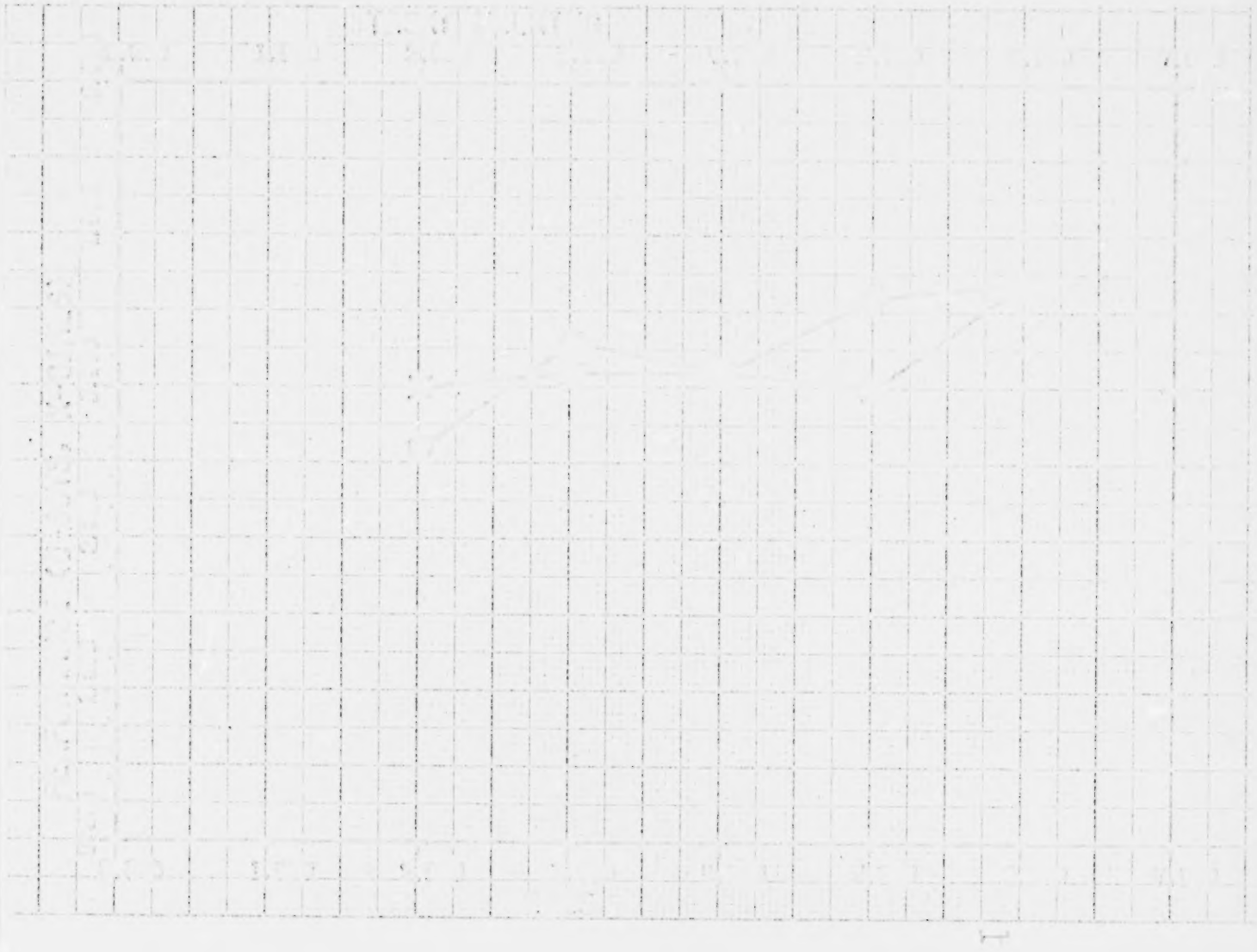
Standing broad jump

CHART 23



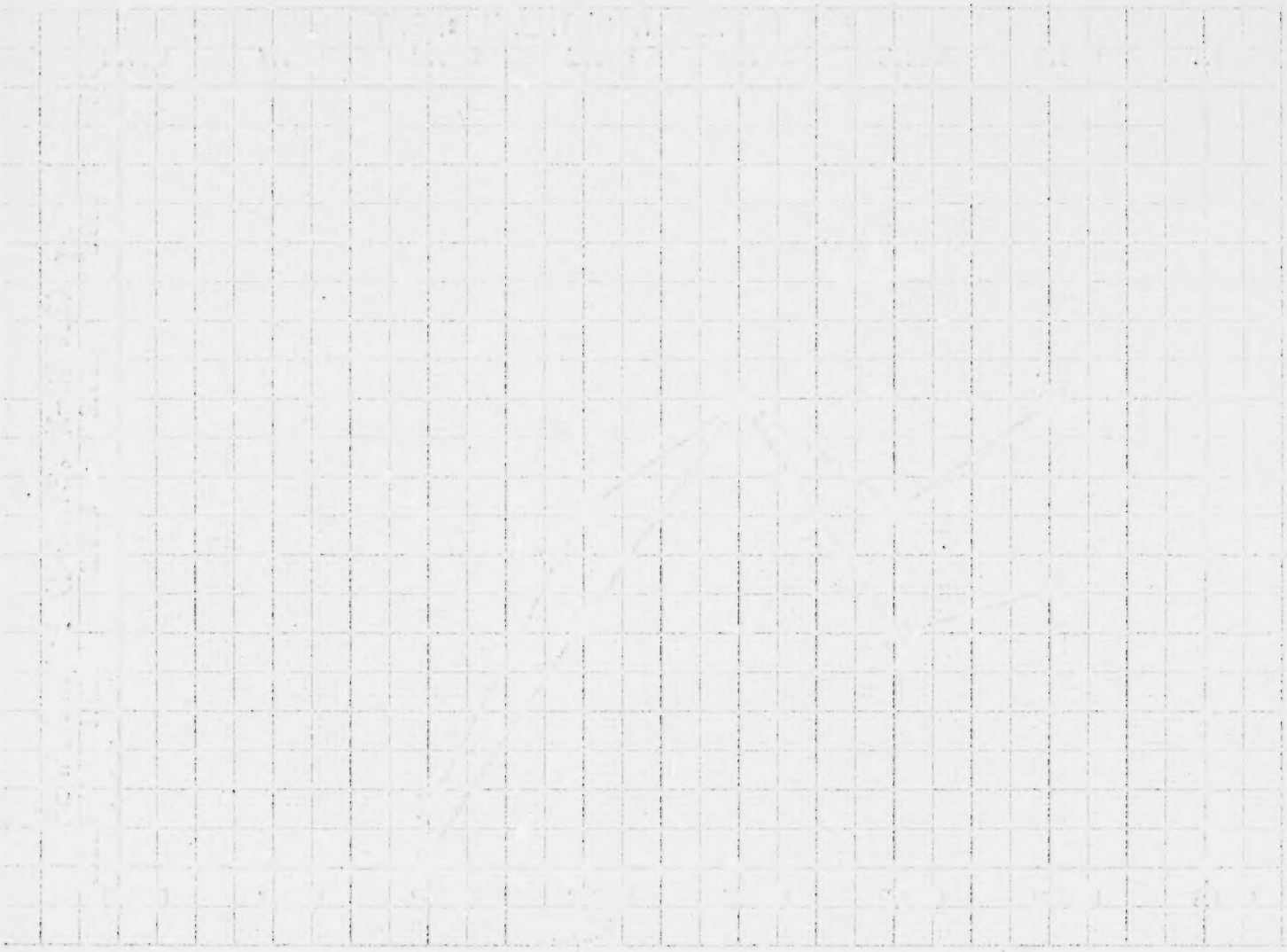
Throwing

CHART 24



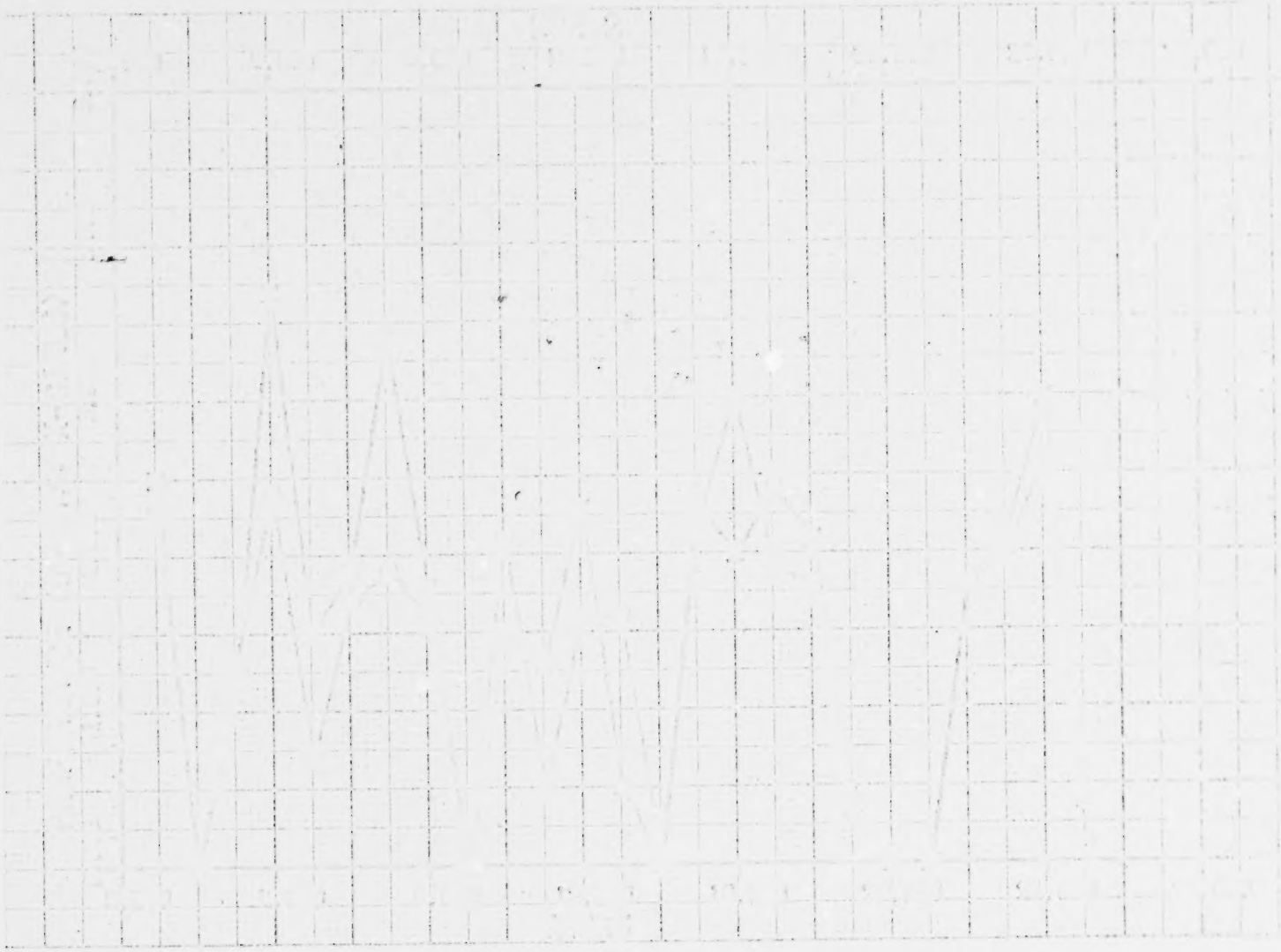
Walking

CHART 25



Walking a beam

CHART 26

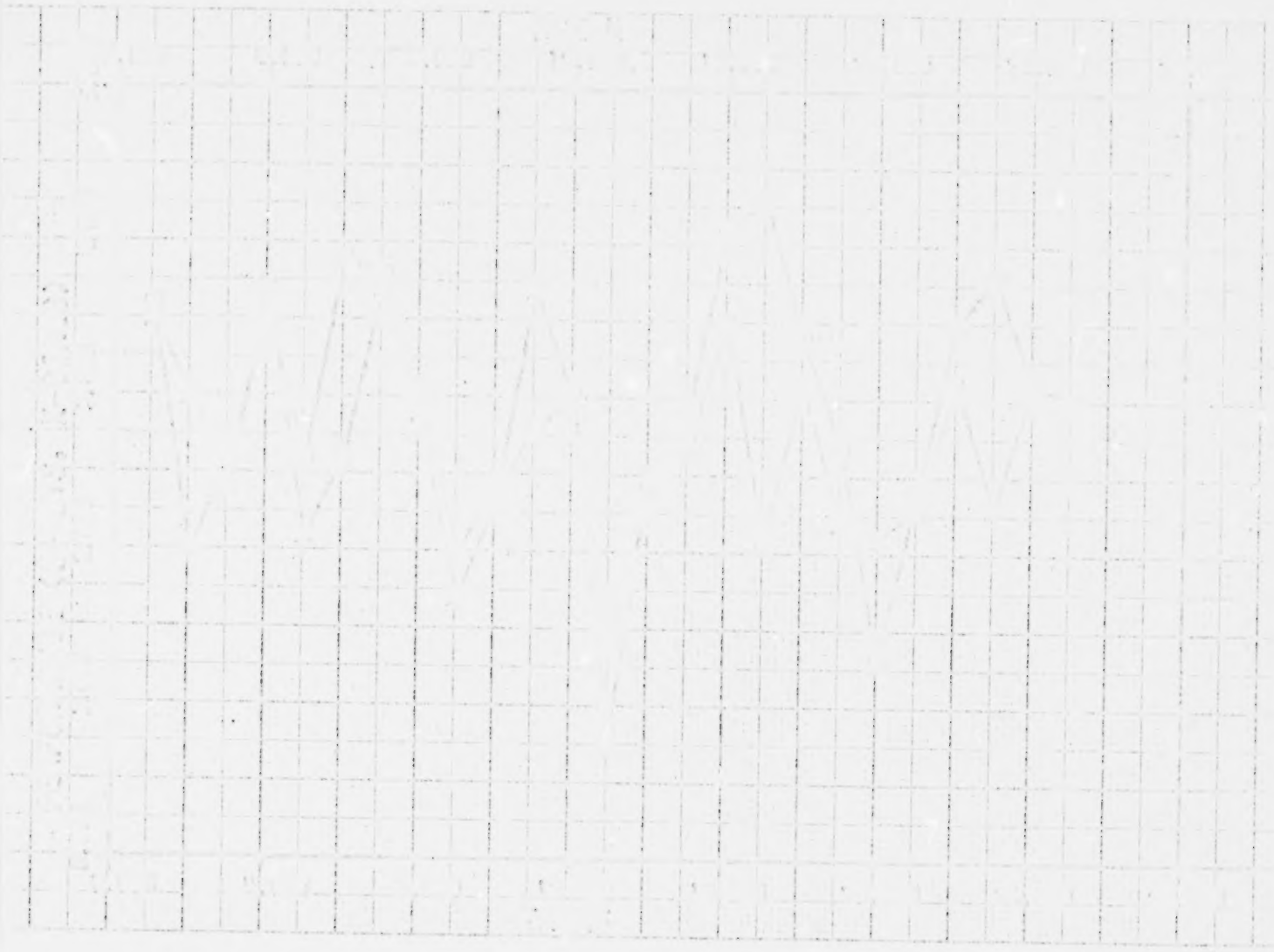


25 Motor Tasks at Age 2

CHART 27

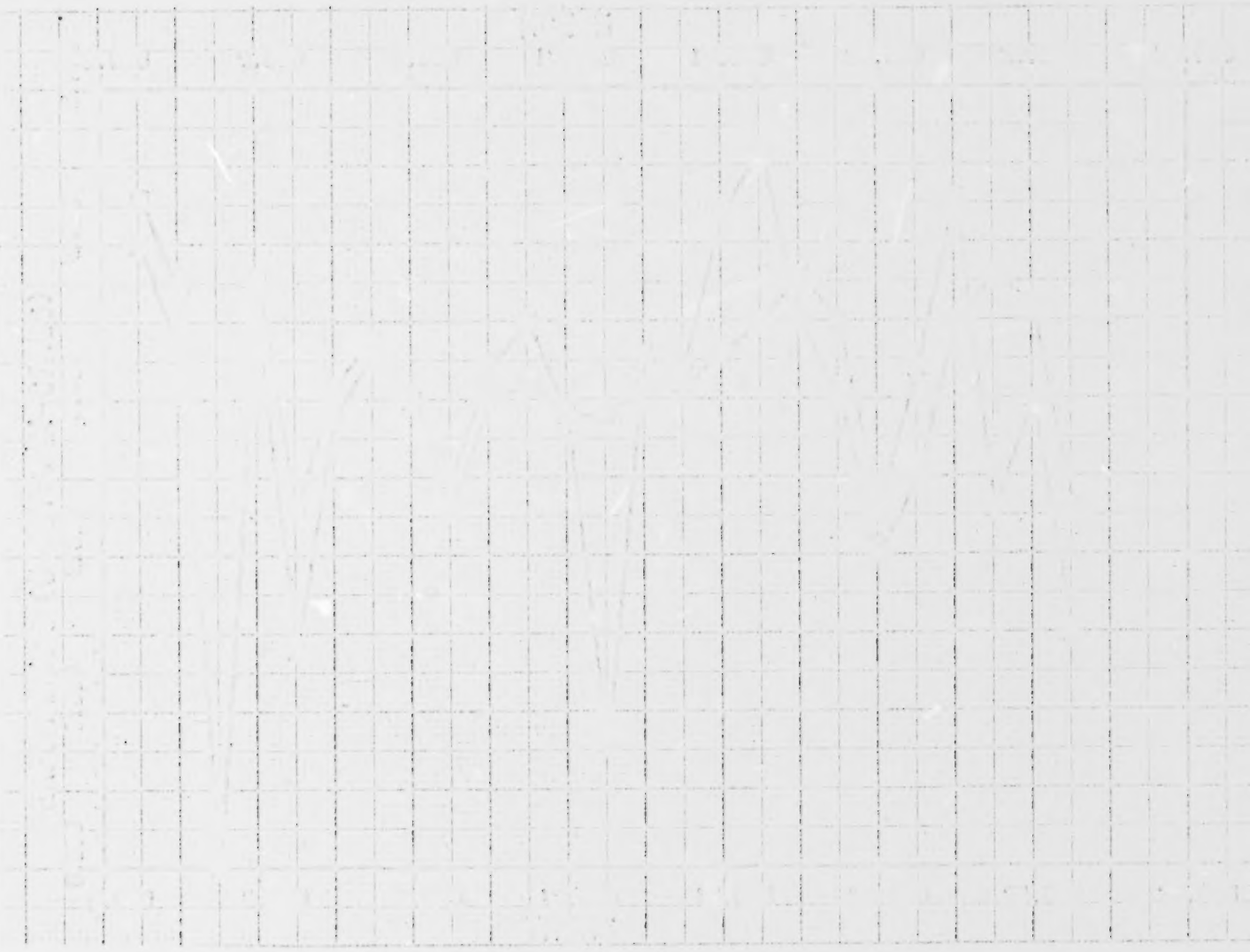
25 Motor Tasks at Age 3

CHART 28



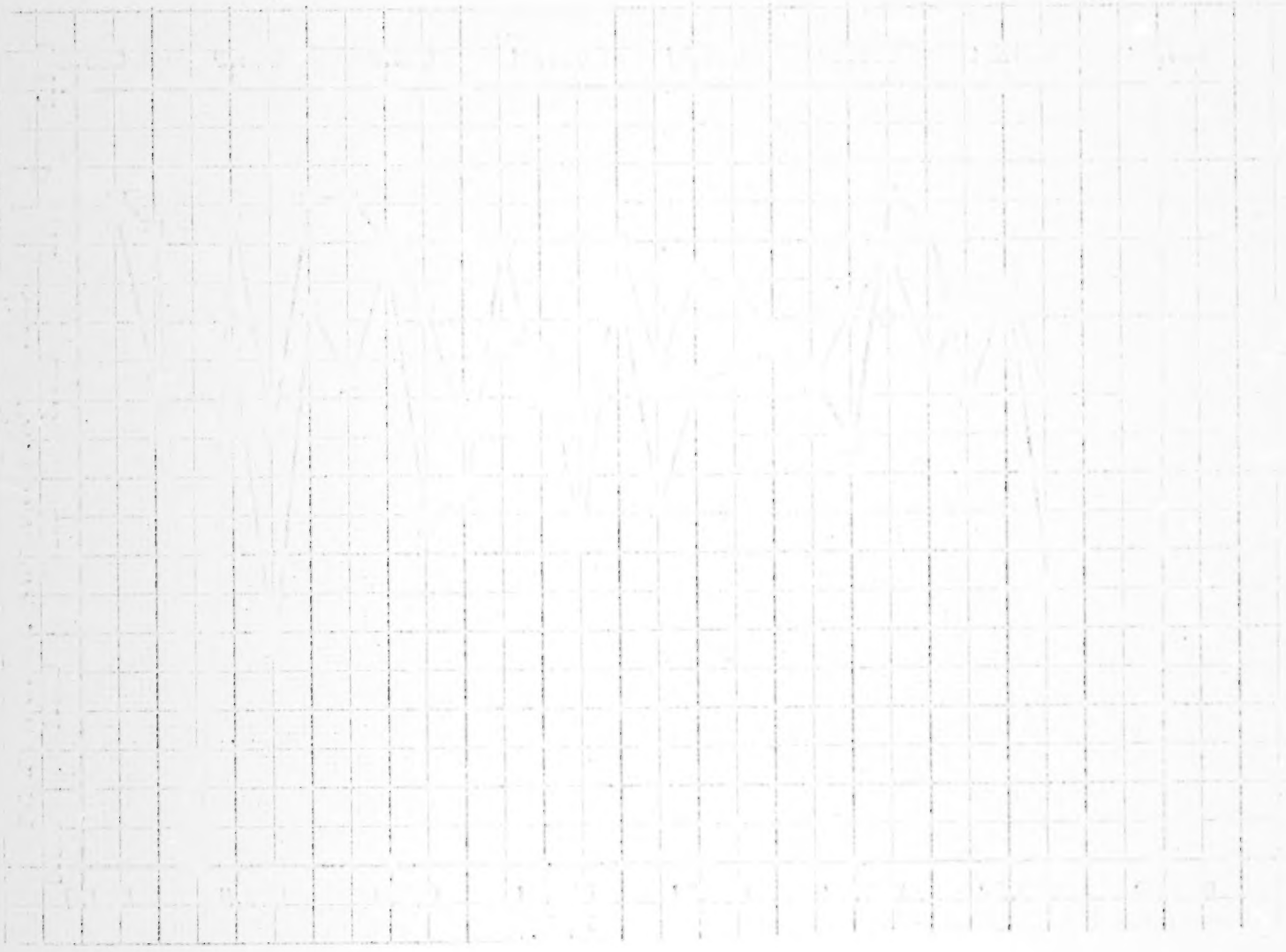
25 Motor Tasks at Age 4

CHART 29



25 Motor Tasks at Age 5

CHART 30



25 Motor Tasks at Age 6

TABLE I

RETENTION OF SUBJECTS BY AGE

	No. Subjects in Study	No. Subjects Completing	Per Cent Subjects Completing
Age 2	30	23	77
Age 3	29	26	90
Age 4	31	28	90
Age 5	25	24	96
Age 6	18	18	100

Summary: 34 subjects or 60 per cent completed all phases of the study

42 subjects or 74 per cent completed at least 75 per cent of the study

50 subjects or 88 per cent completed at least 50 per cent of the study

7 subjects or 14 per cent completed less than 50 per cent of the study

TABLE II

RETENTION OF SUBJECTS BY RACE AND SEX

	No. of Subjects	Per Cent of Total
Boys enrolled	22	39
Girls enrolled	35	61
Whites enrolled	44	77
Blacks enrolled	13	23
Total subjects	57	

TABLE III

MOVEMENT TASKS AND AGE OF SUBJECTS

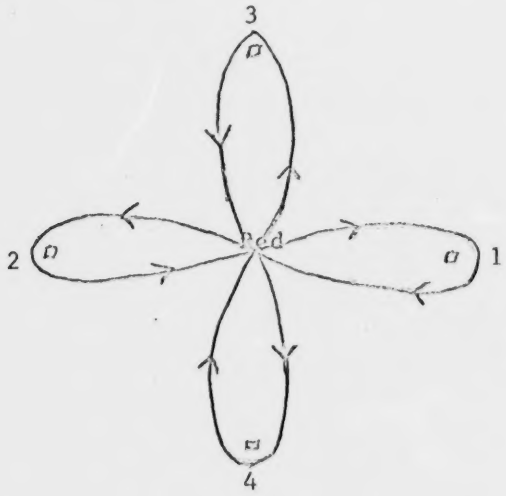
	Ages for Records	Phases of Study	Ages of Occasional Omission	Adjustments of Tasks by Age
Ascending stairs[1]	2-6	1-6	4 and 5	
Bouncing a ball	3½-6	5-6	3½-5	
Bouncing	2-4	3-6		Subjects too heavy at five
Carrying	2-6	1-6	2-5	Weight varied 8-20 lbs.
Catching	2-6	1-6		Large ball 2-4; Small 5-6
Climbing[2]	2-6	1-6		8-ft. ladder 3-5, Ph. V and VI
Creeping	2-6	1-6		
Descending stairs[1]	2-6	1-6	5	
Figure-8-run[3]	3½-6	5 and 6	3½-5	
Forward roll	2-6	3-6		
Galloping	2-6	2-6		
Hanging	2-6	3-6	2-5	
Hitting[4]	2-6	2		
Hopping	2-6	1-6		
Kicking	2-6	1-6		Stationary ball 2-3; Rolling, 4-6
Pulling	2-6	1-6	2-5	Wt. on bench adjusted to size
Pushing	2-6	1-6	2-5	Wt. on bench adjusted to size
Running	2-6	1-6	4-5	Timed at ages 3.5-6
Running high jump	2-6	2-6	4-5	Measured best trial 3.5-6
Skipping	2-6	1-6		
Sliding	2-6	1-6	2-5	
Standing broad jump	2-6	1-6		All in Ph. I; all 2's; thereafter jumped from 12-inch platform
Throwing	2-6	1-6	2-4	Measured distance ages 3.5-6
Walking	2-6	1-6	4-5	
Walking a beam (8-ft.)	2-6	1-6	4	2-in. width for 4's in Ph. II and for 5's and 6's thereafter 4-in. width for all others

Notes for Table III

1. Stairways varied at different stations and therefore for 5's and 6's.

2. Ladders were not available at all schools and jungle gyms were substituted.

3. A central starting point was marked in red; four blocks were placed at distances of 20 feet to mark a square of which the corners were equal distance from the central point. Starting at the center the child was instructed to run around the opposite blocks in two figure 8's, always returning to the center (red-1-2-3-4-red).



4. Several methods were tried. In Phase I the subject was given a paddle and a ball was tossed to him; in Phase II a suspended ball and a small bat were used; in Phases III and IV the two-year-olds used a croquet ball and mallet; the 3's and 4's a suspended ball; and the 5's had several trials if needed at a tossed ball. In Phases V and VI the ball was placed on a batting tee adjusted to the subject in height. Three trials were allowed if needed.

TABLE IV

CORRELATION OF GENERAL FACTORS WITH MOTOR SCORES

	Age within Group	Sex-Maleness	Race-White	IQ	DQ	Achievement Teacher's Estimate	Reading Readiness Percentile Score	Level of Significance for r
Age 2	.67	-.22	-.33	.25	.14	-		.349
Age 3	.60	-.14	-.22	.04	.38	.36		.355
Age 4	.12	.29	-.17	.05		.30		.347
Age 5	.25	.21	-.30	.03		.23		.381
Age 6	.12	.41	-.27	.15		.04	.17	.444

TABLE V

MEANS OF MOTOR SCORES BY AGE AND SEX

	At 2	At 3	At 4	At 5	At 6
Boys	28.1	39.3	53.3	56.0	64.0
Girls	32.3	41.2	50.0	50.6	51.9
Both	31.0	40.5	51.6	52.2	60.9

TABLE VI

MEANS OF MEASURED JUMPS (2), RUN AND THROW BY AGE AND SEX

	Boys 3½	Girls 3½	Both 3½	Boys 4½	Girls 4½	Both 4½	Boys 5½	Girls 5½	Both 5½	Boys 6	Girls 6	Both 6
Running high jump	In. 8.5	In. 12.0	In. 10.6	In. 12.0	In. 17.3	In. 16.0	In. 17.3	In. 19.0	In. 17.3	In. 22.0	In. 20.7	In. 21.3
Standing broad jump	*In. 19.0	*In. 25.8	*In. 20.9	In. 31.0	In. 25.8	In. 30.4	In. 39.6	In. 37.3	In. 38.3	In. 45.3	In. 41.6	In. 42.1
50-ft. run	Sec. 5.74	Sec. 5.57	Sec. 5.58	Sec. 4.70	Sec. 4.63	Sec. 4.65	Sec. 4.53	Sec. 4.65	Sec. 4.58	Sec. 4.19	Sec. 4.20	Sec. 4.19
Distance throw				*Ft. 19.0	*Ft. 17.5	*Ft. 18.5	Ft. 44.6	Ft. 25.0	Ft. 35.7	Ft. 57.4	Ft. 31.9	Ft. 44.6

*These distances were recorded at age given minus six months.

TABLE VII

MEANS OF TASK SCORES BY AGE AND SEX

	Age 2 Boys	Age 2 Girls	Age 3 Boys	Age 3 Girls	Age 4 Boys	Age 4 Girls	Age 5 Boys	Age 5 Girls	Age 6 Boys	Age 6 Girls
Ascending stairs	2.3	2.5	3.4	3.2	*3.6	*3.5	*4.3	*4.0	4.3	4.2
Bouncing a ball			*1.0	*2.0	*2.0	*3.0	*3.7	*3.3	4.1	3.1
Bouncing	1.3	1.1	1.9	2.1	2.6	2.4				
Carrying	2.4	3.7	3.1	3.4	3.5	3.7	3.8	3.5	4.2	3.3
Catching	.7	1.5	2.3	2.2	2.6	2.1	2.3	1.4	2.8	1.4
Climbing	1.7	1.9	2.5	2.6	3.9	2.6	3.1	2.9	4.3	3.6
Creeping	1.9	3.4	3.5	2.9	3.8	3.7	3.4	3.3	4.3	3.1
Descending stairs	1.6	1.8	2.1	2.2	3.0	2.9	*3.0	*3.0	4.0	3.9
Figure-8-run			*.0	*.7	*2.0	*1.7	*2.3	*2.5	3.6	2.2
Forward roll	2.1	1.5	1.5	2.5	2.4	2.3	3.0	3.2	2.8	2.4
Galloping	.5	1.3	2.0	1.7	2.8	3.7	3.1	3.5	3.4	4.0
Hanging	1.6	2.3	1.3	2.6	3.0	3.0	2.9	2.9	3.3	3.0
Hitting	1.6	.5	1.5	1.4	1.4	.8	2.9	.8	2.1	2.8
Hopping	0	0	.2	1.0	2.3	2.5	3.1	3.3	4.0	3.7
Kicking	2.2	2.3	2.7	2.6	2.9	2.7	3.2	3.1	3.2	2.3
Pulling	3.0	2.0	2.6	2.5	4.1	3.5	4.2	3.3	3.8	3.1
Pushing	1.9	2.4	3.1	3.2	4.3	2.1	4.6	3.5	3.7	3.2
Running	1.8	2.1	2.6	2.7	3.4	3.1	3.5	3.8	3.4	3.3
Running high jump	.3	.4	1.4	1.7	2.7	2.2	3.0	3.5	3.1	3.1
Skipping	0	0	0	.2	1.3	2.1	2.0	2.3	3.6	2.7
Sliding	0	0	.7	1.1	2.4	2.3	2.5	3.2	3.9	4.3
Standing broad jump	1.8	1.8	2.5	2.7	3.5	3.1	3.5	4.3	3.2	4.1
Throwing	2.0	2.1	3.7	2.1	3.8	2.3	3.8	2.3	3.6	3.0
Walking	2.6	3.0	3.3	3.1	3.1	3.1	3.6	3.0	3.7	3.7
Walking a beam	.1	.4	1.6	2.3	3.0	3.0	2.3	1.5	3.0	1.8

*These at age given plus six months.

Table VIII

MEANS OF SCORES FOR MOVEMENT TASKS BY AGE

	Age 2	Age 2.5	Age 3	Age 3.5	Age 4	Age 4.5	Age 5	Age 5.5	Age 6
Ascending stairs	2.3	2.4	3.3	3.1	4.5			4.2	4.3
Bouncing on board	1.2	2.1	2.0	2.9	2.5	3.1			
Bouncing a ball				1.6		2.8		3.6	3.6
Carrying	3.3	2.1	3.3	2.4	3.6	4.0	3.7	2.8	3.8
Catching	1.2	2.1	2.3	2.5	2.4	2.5	1.9	1.6	2.1
Climbing	1.8	2.6	2.6	2.5	3.1	3.3	3.0	3.3	3.9
Creeping	2.9	3.6	3.2	3.6	3.8	3.4	3.4	3.1	3.7
Descending stairs	1.7	2.0	2.2	2.5	3.0	3.1	2.7	3.0	3.9
Figure-8-run				.5		1.8		2.4	2.9
Forward roll	1.8	2.0	2.2	2.9	2.3	2.4	3.1	2.7	2.6
Galloping	2.1	2.0	1.8	2.4	3.3	2.7	3.3	4.0	4.2
Hanging	1.9		2.3	2.8	3.0	3.0	3.0	3.6	3.2
Hitting	0.8	2.8	1.4	2.2	1.3	2.7	1.9	2.0	2.4
Hopping	0	.2	.7	1.9	2.4	3.3	3.2	4.3	3.3
Kicking	2.3	2.3	2.6	2.2	2.8	2.4	3.2	2.9	2.8
Pulling	2.2	2.4	2.5	1.8	3.8	3.8	3.6	3.0	3.4
Pushing	2.2	3.7	3.1	2.8	3.2	4.1	4.1	3.2	3.4
Running	2.0	2.3	2.7	2.5	3.2	3.0	3.6	3.5	3.3
Running high jump	.4	.9	1.6	2.2	2.5	4.0	3.3	3.3	3.1
Skipping	0	.2	1.9	.5	1.7	2.9	2.1	2.7	3.1
Sliding	0	0	1.0	1.4	2.4	2.9	2.8	4.6	4.1
Standing broad jump	1.8	3.6	2.6	3.3	3.3	3.0	3.8	3.6	3.7
Throwing	2.1	2.3	2.9	2.7	3.0	2.8	3.1	3.2	3.8
Walking	2.9	2.5	3.2	3.1	3.1	3.4	3.3	2.9	3.7
Walking a beam	.1	1.4	2.3	2.7	3.2	2.9	2-inch beam 1.9	beam at 2.0	5 and 5+ 2.4
Mean for all tasks	31.0	43.5	40.5	45.5	51.6	51.6	52.2	55.4	60.9

TABLE IX

MEANS OF MOTOR SCORES BY PHASE, AGE AND SAME AGE GROUP

	Phase I	Phase II	Phase III	Phase IV	Phase V	Phase VI	Mean of Age	Mean of Same Age Group	r of Age with Motor Score
Age 2	32.1		30.0				31.0		.67
Age 2½		43.8		43.3			43.5		
Age 3	38.4		46.4		38.4		40.5		.60
Age 3½		46.2		48.8		42.5	45.5		
Age 4	52		52.8		49.2		51.6		.12
								38.6	
Age 4½		51.6		51.8		50.8	51.6		
Age 5			53.4		48.5		52.2		.25
								45.2	
Age 5½				54.9		57.5	55.4		
								49.2	
Age 6					60.9		60.9		.12
								54.6	

TABLE X

PERCENTAGE OF SUBJECTS DEMONSTRATING SYMMETRY AND OPPOSITION

	With Synchrony in Creeping	With Synchrony in Climbing	Of Feet in Ascending Stairs	Of Feet in Descending Stairs	Of Feet in Climbing (Ladder)	Of Hand and Foot in Walk	Of Hand and Foot in Run	Of Hand and Foot in Kick	Of Hand and Foot in Skip
	%	%	%	%	%	%	%	%	%
Age 2	23	.03	.14	03	17	.46	80	50	00
Age 3	55	30	89	12	55	59	79	48	04
Age 4	45	29	100	84	65	59	74	50	12
Age 5	44	Jungle	-	92	Jungle	67	91	72	16
Age 6	56	Gym	-	94	Gym	67	100	55	44

TABLE XI

PERCENTAGE OF SUBJECTS DEMONSTRATING DYNAMIC BALANCE

	In Bounce on Board	On Walking Beam	In Hop	Both Feet
	%	%	%	%
Age 2	60	43	00	00
Age 3	70	65	28	00
Age 4	83	100	71	13
Age 5	-	2-in. 56	96	96
Age 6	-	2-in. 77	100	100

TABLE XII

PERCENTAGE OF SUBJECTS DEMONSTRATING 2-PART RHYTHMIC LOCOMOTION

	In Gallop	In Gallop Both Ways	In Slide	In Slide Both Ways	In Skip
	%	%	%	%	%
Age 2	50	00	00	00	00
Age 3	76	14	34	24	7
Age 4	92	58	77	13	52
Age 5	88	68	100	88	89
Age 6	89	83	100	94	100

TABLE XIII

PERCENTAGE OF SUBJECTS DEMONSTRATING TOTAL BODY ASSEMBLY

	Speed		Power		Force		
	In Hit	In Throw	St. Broad Jump	In Running High Jump	In Pull	In Push	In Carry
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Age 2	23	33	28	07	50	63	36
Age 3	52	24	50	45	72	83	48
Age 4	35	48	64	80	90	71	84
Age 5	60	68	76	88	92	76.	64
Age 6	72	88	83	94	100	100	61

TABLE XIV

PERCENTAGE OF SUBJECTS DEMONSTRATING EYE-HAND EFFICIENCY

	In Catching a Ball	In Hitting a Ball	In Bouncing a Ball
	%	%	%
Age 2	67	46	-
Age 3	79	48	*63
Age 4	94	58	*100
Age 5	60	52	*100
Age 6	72	78	89

*Age in six months plus year given.

TABLE XV

PERCENTAGE OF SUBJECTS DEMONSTRATING POSTURAL ADJUSTMENT IN THREE TASKS

	In Walking	In Running	In Standing Broad Jump
	%	%	%
Age 2	73	70	80
Age 3	62	72	76
Age 4	77	94	81
Age 5	84	100	96
Age 6	67	89	89

TABLE XVI

PERCENTAGE OF SUBJECTS DEMONSTRATING AGILITY IN TWO TASKS

	In Forward Roll	In Figure-8-Run
	%	%
Age 2	23	-
Age 3	35	*00
Age 4	42	*25
Age 5	64	*40
Age 6	41	*44

*Age is year given plus six months.

TABLE XVII

DISTRIBUTION OF HAND AND FOOT PREFERENCE AS DEMONSTRATED IN THROWING AND KICKING

	Total No. Subjects	Like Preference	Right Hand Right Foot	Left Hand Left Foot	Mixed Preference	Right Hand Left Foot	Left Hand Right Foot	Uncertain	Hand or Foot
* Age 2	30	24	24	0	4	3	1	2	H 2
Age 3	29	25	25	0	0	0	0	4	F 4
Age 4	31	24	24	0	1	0	1	6	H 3 F 3 B 2
Age 5	25	21	20	1	1	0	1	3	H 2 F 1
Age 6	18	16	15	1	2	1	1	0	0

*Add first figures in each of three sections for total.

CHARACTERISTI

	Dynamic Balance Walking Beam	Hopping	Total Body Assembly Speed - Hitting	Speed Throwing	Total Body Assembly Power St. Broad	Power-Run-High	Total Body Assembly Force-Push	Force-Pull	Force-Carry	Rhy. Locomotion Sliding
t Age 2	*.603		.359		.452			*.520	.428	
t Age 3		.573	.435	.316		.454		.344		.595
t Age 4		.352	.459	*.306	*.499				.395	.344
t Age 5	*.517					.442	.480			
t Age 6	.372		.454							

*P<.05

TABLE XVIII

RACTERISTICS CORRELATING WITH MOTOR SCORE AT OR NEAR SIGNIFICANCE LEVEL

Rhy. Locomotion Sliding	Gallop	Skipping	Opp. and Symmetry Foot-over-Foot Climb	Foot-over-Foot Descending Stairs	Running (Opp.)	Kicking (Opp.)	X-lateral Synchrony Climb.	Postural Adjustment Walking	Eye-Hand Efficiency Catching
		.352			.344				
.595			.322					.354	.354
.344	*.484				.432	*.394	.504		.333
	*.332			.602					.474
						-.344		*.549	

AT OR NEAR SIGNIFICANCE LEVEL

Foot-over-Foot Descending Stairs	Running (Opp.)	Kicking (Opp.)	X-lateral Synchrony Climb.	Postural Adjustment Walking	Eye-Hand Efficiency Catching	Hitting	Agility Forward Roll	Figure-8-Run	Significance Level of
	.344								.349
				.354	.354				.355
	.432	*.394	.504		.333				.347
.602					.474	.455	.371		.381
		-.344		*.549				.465	.444

TABLE XIX

CORRELATION OF FULL MODELS WITH MOTOR SCORES

	No. of Characteristics in Full Model	r with Motor Score	Significance Level of r
At age 2	4	.720	.349
At age 3	10	.869	.355
At age 4	8	.896	.347
At age 5	8	.925	.381
At age 6	5	.825	.444

	Level of Significance	Opposition and Symmetry						Dynamic Bal. on Walking Beam	Gal
		Opposition in Walk	Opposition in Kick	Foot-over-Foot Descending	Foot-over-Foot Climbing	X-lateral Synchrony in Creep.	X-lateral Synchrony in Climb.		
Age 2	.349			.284					-.3
Age 3	.355	.368	-.329		.419				
Age 4	.347		-.360		.267	.349	.276		.54
Age 5	.381							.277	
Age 6	.444							.267	

TABLE XX

MOVEMENT CHARACTERISTICS MOST HIGHLY CORRELATED WITH MALE SEX

X-lateral Synchrony in Creep.	X-lateral Synchrony in Climb.	Dynamic Bal. on Walking Beam	2-Part Rhythmic Locomotion			Total Body Assembly					
						For Speed		For Power		For Force	
			Gallop	Slide	Skip	Hitting	Throwing	Standing Broad Jump	Running High Jump	Pulling	Pushi
			-.364			.327					
							.389				
.349	.276		.546	.335			.678		.445	.297	.438
		.277			-.355	.360		-.599		.307	.397
		.267				.620	.354				

LY CORRELATED WITH MALE SEX

Total Body Assembly					Eye-Hand Efficiency		Agility		Postural Adjustment	
Speed	For Power		For Force							
Throwing	Standing Broad Jump	Running High Jump	Pulling	Pushing	Hitting	Bouncing Ball	Forward Roll	Figure-8-Run	Walking	Standing Broad Jump
					.262					
.389										.316
.678		.445	.297	.438						
	-.599		.307	.397	.359					
.354					-.535	.354	.354	.671		.354

TABLE XXI

RANGE OF SCORES ON MOVEMENT TASKS

	Age 2 I	Age 3 I	Age 3 II	Age 4 I	Age 4 II	Age 5 I	Age 5 II	Age 6 I
Ascending stairs	0-4	2-4		3-5			3-5	3-5
Bouncing a ball			0-4		2-4		2-5	0-5
Bouncing	0-2	5-3		5-4				
Carrying	0-5	0-5		2-5		0-5		2-5
Catching	0-3	0-3		0-5		Small ball 0-4		Small ball 0-5
Climbing	0-3	1-5		0-5		0-5		3-5
Creeping	0-4	2-5		2-5		2-5		0-5
Descending stairs	0-2	2-4		2-5			2-4	2-5
Figure-8-run			0-2		0-3		0-5	2-5
Forward roll	0-4	0-4		0-4		2-4		0-5
Galloping	0-2	0-5		0-5		0-5		0-5
Hanging	0-3	2-3		3		2-3		1-4
Hitting	0-4	0-5		0-5		0-5		0-4
Hopping	0	0-4		0-5		2.5-5		2-5
Kicking	0-4	0-5		0-5		0-5		0-5
Pulling	0-5	0-5		0-5		0-5		2-5
Pushing	0-5	0-5		0-5		0-5		2-5
Running	0-4	2-4		2-5		2-5		2-5
Running high jump	0-3	0-4		0-4		0-4		2-4
Skipping	0	0-3		0-4.5		0-5		2-5
Sliding	0	0-4		0-5		0-5		2-5
Standing broad jump	0-5	0-5		2-5		2-5		0-5
Throwing	1-4	2-5		2-5		2-5		2-5
Walking	2-5	2-5		2-5		2-5		2-5
Walking a beam excluding line in Phase I	0-2 4 in.	0-5 4 in.		3-4 4 in.		0-4 2 in.		0-5 2 in.

TABLE XXII

TEN SUBJECTS WITH GREATEST NEGATIVE DEVIATIONS FROM MEAN OF MOTOR SCORE

	Negative Deviations from Mean	Place in Group-Youngest to Oldest	Sex	Race	Generally Low in Score	Low in Eye-Hand Efficiency (No. of Factors)	Low in Dynamic Balance (No. of Factors)	Low in 2BA Power (No. of Factors)	Low in Rhythmic Locomotion (No.of Factors)
ubject 040	-14.9	1	F	W	x				
023	-13.2	4	F	W	x	x	x	x	
057	-11.9	2.5	M	W	x				
024	-10.1	3	M	W	x		xx	x	x
015	-10.1	5	F	W	x	x	x		xx
010	-9.9	10	M	B	x	xx	x		
056	-9.3	1	M	W	x				
008	-8.7	12		W	x		x		
054	-8.6	4	F	W	x				
014	-8.2	6	F	W	x	xxx	x		
otal		48.5			10	7	7	2	3

TABLE XXIII

TEN SUBJECTS WITH GREATEST POSITIVE DEVIATIONS FROM MEAN MOTOR SCORE

	Positive Deviations from Mean	Place in Group-Youngest to Oldest	Sex	Race	Generally Low in Score	High in Eye-Hand Efficiency (No. of Factors)	High in Dynamic Balance (No. of Factors)	High in 2BA Power (No. of Factors)	High in Rhythmic Locomotion (No. of Factors)
Subject 006	19.5	14	M	B	x	xx	xx	xx	xxx
026	15.4	1	M	W	x	xx	xx	xx	
045	13.7	13	F	W	x	xx	xx	xx	xxx
042	13.4	15	F	B	[1]x	xx	xx	xx	xxx
001	12.0	19	M	B	x	x	x	xx	[1]
035	11.1	7	F	W	x			xx	x
044	10.0	14	M	W	x	x			
052	7.1	6	F	B	[1]x	[1]	x	x	xxx
019	6.4	1	M	W	[2]x		xx	xx	xxx
011	5.2	9	F	B	x		xx	xx	xxx
Total		99			10	10	14	17	19

[1]Erratic in performance
[2]Scored 0 on hitting in all phases